THE TRAGIC SCIENCE OF LEO SZILARD

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A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1994

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Abstract of Dissertation Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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April, 1994

Chairman: Professor Frederick Gregory
Major Department: History

By exposing the tragic nature of Leo Szilard's science, the images of nuclear science, especially the image of nuclear science as an arcanum, emerge within the sharp focus of Szilard's work, exposing a mythology of nuclear science in the twentieth century. In his autobiographical "Recollections," Szilard described the metaphorical qualities of his science as he told the story of his childhood in Hungary. These images reverberated the metaphorical realm of Hungarian tragedy as expressed in Imre Madach's *The Tragedy of Man*, and the dissertation explores Madach's tragedy in order to locate the tragic images used by Szilard to explain himself and his understanding of science in the "Recollections." Using these images, the dissertation then explores the political nature of Szilard's "tragic science" as expressed in Szilard's proposal for a scientific youth organization, inspired by the German youth

movement, and the political science that Szilard espoused after World War II when Szilard emerged as a liberal oracle for world peace and nuclear disarmament. The dissertation also displays the images inscribed in Szilard's political science by describing his science fiction. Szilard's political science imagined that science would have a special role in saving the world. His science fiction portrayed the tragic character of the scientist unable to control a world created by his vision, yet envisioned possibilities in which the creations of science and the creative scientist still might be able to save the world. Finally, recalling all of Szilard's tragic voices, the dissertation recounts the metaphorical reality of Szilard's scientific papers and displays the tragic vision of Szilard's thermodynamic world that led him to his most powerful "discovery," the transmutation of chemical elements. It concludes with an analysis of the pervasive role of transformational power in his understanding of nuclear power.

INTRODUCTION

Born in Hungary in 1898, Leo Szilard came to Berlin in 1919 and discovered the world of physics. He studied with legendary figures such as Albert Einstein and Max von Laue and associated with many of the soon-to-be-legendary figures in nuclear physics such as Eugene Wigner. Szilard himself became a sort of mythical figure in the world of nuclear physics by pursuing the idea of nuclear power to its catastrophic end. In brief, the story of Leo Szilard was as follows. He fled Hitler and came to live in the United States in 1938. There, he worked with Enrico Fermi at the Metallurgical Laboratory in Chicago as a part of the Manhattan Project. This laboratory, with Szilard as one of the intellectual and emotional leaders, developed the concept of a nuclear chain reaction into a working nuclear reactor. As a result of Szilard's involvement in this work, he came to be known as one of the "fathers" of the atomic bomb.

Not always pleased with his progeny, Szilard sought to control or eliminate the more sinister side of his nuclear child. To that end, Szilard campaigned for the peaceful use of atomic energy, fought against the buildup of nuclear arms and warned of the dangers of a nuclear arms race.[1] His

greatest weapon in this battle to save the world from nuclear destruction was his public opinion as expressed through Congressional hearings, interviews with the media and his writings. He consented to a number of interviews from the 1940s to the 1950s and early 60s, debated proper atomic energy and weapons policy with politicians and scientists, and wrote various articles for *The Bulletin of the Atomic Scientists*.[2] He even enjoyed some literary success with the book *The Voice of the Dolphins and Other Stories* (1961).

Throughout his life, Szilard made a great effort to save documents that he thought might be important in telling this story. As the editors of the second volume of his published papers phrased it, "he had a sense of history."[3] This "sense" resulted in the conceptualization of an autobiography, but Szilard, for whatever reason, never wrote it. Instead, what we have to represent Szilard are the "Recollections." "Recollections" was an edited transcription of tape recorded sessions in which Szilard "responded with zest to questions about his past," sewn together with fragments from his writings on his life.[4]

In composing the "Recollections," the editors attempted "to use only a minimum of scholarly apparatus and let Szilard himself speak."[5] But the pristine speech of Szilard cannot, of course, be found here. Always we are given a recollection of the Szilard's version of the facts. To

search for the original speech, for the real version of Szilard's speech or facts, involves an infinite regression into the origins of this text. There is no escape from this infinite regression, even if an attempt is made to reduce the texts of Szilard's life to something outside themselves, such as the speech acts of Szilard, the psychological forces of Szilard's psyche, or the social, economic and political structures that shaped Szilard.

According to an interesting anecdote provided by the editors of the "Recollections," Szilard confronted this issue when some colleagues queried him about his insistence on writing down the "facts" about the Manhattan Project:

> Szilard said that he was going to write down the facts, not for publication, just for the information of God. When his colleague remarked that God might know the facts, Szilard replied that this might be so, but "not <u>this</u> version of the facts."[6]

In addition to illustrating the character of Szilard, this interesting reply captured the futility of viewing Szilard's version of the facts as representing something outside the "facts" as they were constituted in Szilard's telling of them, his version of the facts. The "facts," as Szilard recalled them, crystallized Szilard's idea of himself and bound him to the events or facts about the past in a way that revealed the myriad of images inscribed in the story of Szilard and his science. In recalling the past, then, Szilard established his story and, simultaneously, separated himself from the events in the story. That separation gave

Szilard's version of the facts a certain authority. Szilard, in other words, became the author of his past and presented a story that begs to be read as more than a simple recounting of the past.

Other historical versions of Szilard's story, such as William Lanouette's recent biography, *Genius in the Shadows*, have concentrated on the events in Szilard's story, leaving Szilard's version of the facts largely intact.[7] Because they have focused on reiterating Szilard's story, they have missed the significance of Szilard as the author of a story about himself and science, and implicitly retained the shadowy, neo-romantic metaphors of Szilard's story inscribed in the "Recollections." This dissertation will focus primarily on making explicit the metaphorical nature of Szilard's story about himself and science in the "Recollections" and in all of the scientific, political, and fictional works that he authored. This work will be primarily concerned with Szilard's representation of the facts in order to help us understand the history of the images inscribed in Szilard's story.

Like many scientists, Szilard understood science in terms other than the mathematics and scientific knowledge that made up his scientific work. In the "Recollections," Szilard described the metaphorical qualities of his science as he told the story of his childhood in Hungary. In the first chapter, the focus will be on the images of himself

and science that Szilard created in recalling his childhood. These images echoed the metaphorical realm of Hungarian tragedy as expressed in Imre Madach's *The Tragedy of Man*, and chapter two will explore Madach's tragedy in order to locate the tragic images used by Szilard to explain himself and his understanding of science in the "Recollections."

Chapter three will then describe the political nature of Szilard's "tragic science" as expressed in Szilard's proposal for a scientific youth organization inspired by the German youth movement. Proceeding from this understanding of Szilard's political science, chapter four will discuss the mythological significance of Szilard's political science in the post World War II period in the United States, when Szilard emerged as a liberal oracle for world peace and nuclear disarmament. In this period, Szilard's political science imagined that science would have a special role in saving the world, and chapter five will explore the images inscribed in Szilard's political science by exploring his science fiction. In his fiction, largely written after World War II, Szilard recalled the tragic elements of his science as he tried to escape and transform a nuclear world held prisoner by a cold war mentality. In his fictional depictions of the future of a MAD (mutual assured destruction) world and his visions of world transformed by science, Szilard portrayed the tragic character of the scientist unable to control a world created by his vision.

Recalling all of these images inscribed in Szilard's characterization of science, the final two chapters will then de-scribe the metaphorical reality of Szilard's scientific papers. Chapter six will display the tragic vision of Szilard's thermodynamic world as seen in his papers on thermodynamics, and chapter seven will display the transmutational character of Szilard's powerful "discovery," the transmutation of chemical elements. By exposing the images of Szilard's science in these two chapters, the images of nuclear science, especially the image of nuclear science as an arcanum, will emerge within the sharp focus of Szilard's work, exposing the historical context of the mythology of nuclear science in the twentieth century.

In its concern for explicating the historical development of the images of nuclear science, the perspective of Leo Szilard outlined here emerged from reading Spencer Weart's *Nuclear Fear: A History of Images*.[8] Inspired by the work of Claude Lévi-Strauss, Weart considered the role of images or myths in reconciling cultural conflicts and explicating the communicative symbols that arbitrate our understanding of nuclear science. To accomplish his objective, however, Weart made the terms image and myth synonymous with the absence of "Truth" or "reality." Defined in this way, images and myths represented only "internal experiences . . . that people project back onto the external world."[9] For Weart, images were like

pictures, real because one can touch, feel, or see them, but false because they only represented external reality. True statements, therefore, could be made about these images/myths, but the images remain false in an absolute empirical sense. In *Nuclear Fear* Weart's images did not operate within a closed system. The empirical arbiter always remained--true science. Weart always described "true science" in contra-distinction to the images/myths surrounding it. In that way, good images were distinguished from bad, and true understanding of nuclear science overcame nuclear fear.

The continuation of this image/myth of nuclear science was the main focus of this book. *Nuclear Fear*, therefore, offered a therapeutic exercise for those already committed to the authors ontological categories. His prescription was an objectification of our primal fears concerning nuclear science and technology. Animated by the work of Carl Jung, Weart saw the images that have surrounded nuclear science as having originated in the primal hopes and fears of humanity. These primal feelings and attitudes created associations in the mind which crept into people's perceptions of nuclear science in the twentieth century. Slowly, atomic power came to signify hope, enlightenment, knowledge of the innermost secrets of nature, the quest after cosmic mysteries. Dialectically, fear also emerged and surrounded nuclear science as individuals and western culture sought to

suppress natural childish curiosity about the "mysteries of sex and birth"/ "the inner structure of matter." Thus, instinct combined with traditional myths led people to both extol and fear nuclear science.[10]

At the core of Weart's symbolic field was the arcanum, nuclear science and its technical realities as interpreted by scientists. This represented the reality of nuclear power and was surrounded by images/myths of public interpretation, social and political ideology, and primal feeling, all of which were not a part of the arcanum. Weart saw it as possible to escape the images/myths engulfing the arcanum by appealing to the arcanum itself to arbitrate which symbols were appropriate and which were not. In the final chapters of the book, Weart considered what he called an artistic transmutation in which we "imagine ourselves and our society reformed" through new and better images and a purging of the propagandistic images associated with nuclear fear. These latter nihilistic images of despair must be replaced by images "pointed toward a more modest and more realistic kind of spiritual rebirth."[11] The source of this rebirth was to be the arcanum itself.

Recognizing that the very notion of arcanum entails both the power of birth and death, it is hard to understand how reliance on the modern arcanum will lead to re-birth and not death. After all, one cannot purge the power of death from an arcanum. Were it possible, then what is left would

not be an arcanum and, therefore, could not and would not be the source of all birth and death or the final arbiter in all questions of truth. Perhaps what needs to be examined historically is the context of the image of the arcanum itself and how it came to be attached to nuclear science; in other words, to describe historically what Weart's understanding of images does not recognize- the necessary connection between the authority of science and the "images" of science.

Cultural images were not external to nuclear science. They were not separate symbolic entities that interacted through the actions of human beings with nuclear science or cultural symbols that somehow derived from the arcanum, nuclear science. The significance of nuclear science lay in its re-presentation of cultural symbols, and it reiterated many cultural symbols. It cannot be separated from them, and they cannot be derived from science. Nuclear science's authority came from its distillation of cultural symbolism, in its "novel" quality displayed always already within cultural symbols. In this sense, nuclear science was as much cultural myth as any other symbolic representation.

Proceeding from this understanding of nuclear science, this presentation of Leo Szilard's science will attempt to recognize the qualities of Szilard's scientific culture and display his science without fearing the power of nuclear science as the arcanum of the twentieth century or

apologizing for Szilard's nuclear science in order to relieve guilt over a childish infatuation with science. Instead, this analysis of Szilard's science will narrate the images of Szilard's science in order to understand his and his science's cultural authority. This will be done by displaying the many voices of Leo Szilard's science and searching for their historical tempo.[12] This search will take us from the classic Hungarian tragedy of Imre Madach and the literature of thermodynamics in the early twentieth century, through the political mine field of the *Jugendbewegung* of Weimar Germany and the transmutational contexts of nuclear science in the 1930s, to the political and fictional realities of the nuclear world in the post World War II era. Leo Szilard's arcanum, the transmutation of chemical elements, emerged from this contextual maze, gave life to Szilard's tragic visions of creation and destruction, and animated a prophetic image of nuclear science in the twentieth century.

Notes

1. See Alice K. Smith, *A Peril and a Hope* (Cambridge, Mass.: M.I.T. Press, 1970), for an account of Szilard's involvement in the atomic scientists' peace movement. See also Barton Bernstein, "Introduction," in Leo Szilard, *Toward a Livable World: Leo Szilard and the Crusade for Nuclear Arms Control*, Helen S. Hawkins, G. Allen Greb, and Gertrude Weiss Szilard, eds. (Cambridge, Mass. and London: The MIT Press, 1987).

2. Most of this is in the third volume of his published papers, *Toward a Livable World: Leo Szilard and the Crusade for Nuclear Arms Control*. Hereafter cited as *Toward a Livable World*.

3. Leo Szilard, *Leo Szilard: His Version of the Facts*, Spencer R. Weart and Gertrude Weiss Szilard, eds. (Cambridge, Mass.: The M.I.T. Press, 1978): xvii. Hereafter cited as *His Version of the Facts.*

4. Leo Szilard, "Recollections" in *Leo Szilard: His Version of the Facts*. The quotation is from the editors' introduction.

5. Ibid.

6. Szilard, *His Version of the Facts*, xvii.

7. William Lanouette with Bela Szilard, *Genius in the Shadows: A Biography of Leo Szilard, the Man Behind the Bomb*. (New York: Charles Scribner's Sons, 1992). Lanouette's biography is a good and entertaining recapitulation of Szilard's life with some important contributions to the story, largely gleaned from interviews with Bela Szilard, Leo's brother, and letters that Lanouette obtained from the estate of Leo Szilard's wife, Gertrude Weiss Szilard. The work presented here will call upon this valuable source occasionally, although the focus here will be on Szilard's own story, the "Recollections."

8. Spencer Weart *Nuclear Fear: A History of Images* (Cambridge, Mass. and London: Harvard University Press, 1988). My concern with the metaphorical nature of Leo Szilard cannot help but have originated in some sense from Thomas Kuhn's presentation of the problem of translation in *The Structure of Scientific Revolutions*. (See "Postscript" in Thomas Kuhn, T*he Structure of Scientific Revolutions*, 2nd ed., enlarged (Chicago, Il.: The University of Chicago Press, 1970): 174-210.) Contrary to some in the sociology of science, I do not believe that the so-called problem of the paradigm is one of trying to establish a method, a way, or a central metaphor whereby we can translate one paradigm into another. As a historian I do not seek to establish a unique linguistic link that supposedly allows us to escape the paradigm or to establish an authoritative paradigm such as "material culture." Such an attempt is inherently contradictory because it requires the construction of knowledge in a context but exempts certain sociological paradigms from the process or simply incorporates the positivistic ontology heretofore associated with the "hard" sciences into the social sciences.

For that reason my study does not begin or proceed from any anthropological methodology. I see myself as beginning with the problem that "in fact" we cannot constitute knowledge in any other way but "in language," mathematical or otherwise. My problem in confronting the writings of Leo Szilard is, therefore, akin to the dilemma of the linguist

who can always translate one language into another, but can never present a final translation that completely comprehends what is being translated. From this perspective, the problem of the paradigms is a semiotic one, one of establishing that the signs that we use to signify nature have meaning. Meaning in science and in history comes in the interpretation of symbols, assigning them a certain reality, and describing in very precise terms the nature of that scientific or historical reality. This suggests that our historical understanding of "science" can be transformed if we concentrate on de-scribing the form of scientific texts, because it is in the texts of scientists, in the idealization of the many contexts which continually crystallize in a scientific text into a particular form, that science is constituted. Science always has an author and tells a metaphorical story inscribed with cultural images and described as science. As a historian of science, I choose to be concerned with the historical de-scription of science and recall all the images inscribed in science. In so doing, a different story will emerge, one that seeks to give new historical meaning to an old story and opens up a different context for understanding the nature of science.

9. Weart, *Nuclear Fear*, pg. 2 of Preface.

10. Ibid., 56-57.

11. Ibid., 407.

12. One should be careful in this exercise not simply to replace the factual ontology of science with an archeology of knowledge. Such an undertaking has the effect of killing science by pronouncing scientific ontology dead and resurrecting that very same ontology embalmed with primal cultural symbols and protected by the shroud of traditional scientific images. Science, like a religious relic, remains a modern mystery sustained by an archeological scientific mythology. This is what Weart did in *Nuclear Fear*.

PART I
TRAGIC SCIENCE DESCRIBED

CHAPTER 1
THE ORIGINAL QUALITIES OF LEO SZILARD

In his "Recollections," Leo Szilard offered a unique blend of idealism and sociological analysis to describe himself. The "I" that Szilard described did not originate with his physical birth in Budapest, Hungary, on February 11, 1898. It began with the idea of becoming a scientist, and Szilard associated his becoming a scientists with his physical birth. He described himself as having been "born a scientist" and having "remained a scientist" because he retained the "inquisitive mind" of a child, and he connected this inquisitiveness with "the mind of a scientist." In this strange mixture of birth and mental attitude, Szilard introduced himself and implied that every part of his life, even his physical birth and development, were inextricably intertwined with science:

> As far as I can see, I was born a scientist. I believe that many children are born with an inquisitive mind, the mind of a scientist, and I assume that I became a scientist because in some ways I remained a child.[1]

This identification activated an image of Szilard and science, mixing the two, and created an allegorical origin for both. If one is to become a scientist, he explained, one

must have and retain childlike inquisitiveness. We are all born with an inquisitive mind. As children, we inquire into or about our surroundings. The child's mind interacts with everything and produces knowledge. Children continuously ask questions, never satisfied with an answer, and by asking questions they come to know. This innocent game is devoid of arbitrary rules and opinions, and is a free activity that cannot be constrained.

Even though we cannot completely comprehend Szilard's allegory of innocence by reducing it to the historical facts surrounding his birth, our historical examination of this allegory will begin by examining the context of Szilard's story.[2] At the time of Leo Szilard's birth on February 11, 1898, Hungary remained a part of the increasingly unstable Austro-Hungarian Empire. In 1867, Austria and Hungary compromised on Hungarian autonomy, and a dual administration over greater Hungary was established. Vienna controlled the foreign affairs, defense, and finances of Hungary, while the ethnic hungarians or magyars, especially the traditional noble magyars, administered the rest, restoring Hungarian constitutional authority and preserving the appearance of an independent Hungary.

A legalistic liberal ideology guided this semi-independent Hungarian government. Its agenda included all of the traditional liberal concerns such as legal equality of men, civil rights, constitutional government,

the promotion of capitalism, and the separation of church and state. These liberal ideals, however, were not applied to all segments of the population. The land-holding nobles and the gentry, who dominated Hungarian politics, did not grant these traditional liberal rights to the lower classes- peasants, farm laborers, poor farmers- or to non-Magyar people. These lower classes were "the great disenfranchised majority" in a country just beginning to embrace liberalism and industrialization but still dominated by a large land-holding nobility and a civil service oriented gentry.[3]

In this land of old and new, where the ideas of liberalism and capitalist industrialization slowly merged with a land-based economy and social structure, the Jewish section of the population rose in social and economic standing. Liberal laws, such as The Jewish Equality Law of 1867, allowed the Jewish population to take part in the political arena of Hungary by granting them political and civil equality with Christians, and industrialization provided them with an economic niche.[4] They became the leaders of the industrialization of Hungary, filling the economic gap created by the rise of industrial capitalism and the aversion of nobles and gentry to economic change.[5] Jews became, in other words, the major component of a small Hungarian industrial middle class that grew and prospered in the cosmopolitan atmosphere of turn of the century Budapest.[6]

Leo Szilard was born into this turn-of-the-century Budapest, struggling to make sense of itself, caught between "the modern world" of industrialization and liberal nationalism and the "old world" of rural agriculture and the noble hierarchy. His family was Jewish and middle class. His father was an engineer and his mother "selfless and moral."[7] He lived in the cottage district of Budapest in a large house that his mother and her sisters had inherited from their parents. He had governesses in his home to teach him French and German, and he attended the heralded *Minta* or model *Gymnasium* founded by Theodore von Karmen's father. In 1916, he began his college studies in electrical engineering at the King Joseph Institute of Technology

Called to serve the Empire in 1917, he spent his military time in officers' training school in the *Kaisergebirge* until he became ill with the flu, went home on leave, and, through "family connections," recuperated in a hospital in Budapest. After his service, he returned briefly to the Institute of Technology to continue his studies in electrical engineering before deciding that it would be best to pursue an academic career in Germany. After a lengthy struggle with the Hungarian bureaucracy, in disarray because of the collapse of Bela Kun's communist revolution and the coming to power of Nicholas von Horthy, Szilard finally obtained a passport and arrived in Berlin in early 1920, where he would discover the world of German physics.[8]

This brief synopsis of Szilard's early life establishes a context for understanding Szilard's allegorical "Recollections" of his early life. Szilard's story can be understood within the historical context of Hungarian industrialism, liberalism, nationalism, conservatism and Judaism. As a part of the middle class in Budapest, Szilard benefitted from the opportunities available to those in the Budapest bourgeoisie. His early life and educational goal, electrical engineering, recall the story of the industrial middle class in Hungary caught up in and committed to industrial development, and the liberal policies of the Magyar nationalists allowed Szilard to participate in the cosmopolitan culture of Budapest imbued with concepts associated with modern industrial development. The economic opportunities that he and his family enjoyed were largely the result of a liberal policy that encouraged industrial development and prescribed a civil order that allowed for Jewish participation in this development. Jews were given civil rights. They were not persecuted *en masse* as they would be later, and, while anti-semitism did not disappear, Jews were allowed to become a part of an industrial middle class that wielded power and influence in Budapest. This provided a stable environment for Szilard's family and for Szilard himself. His father was allowed to work as an engineer. His mother's family followed their religion without political persecution. Szilard went to public

schools and pursued an engineering career at a public university, absorbing in the process those liberal ideals that structured his early existence and formed the basis for his commitment to individual freedom and scientific progress.

The Magyar nationalists also attempted to assimilate the urban Jewish population of Budapest into Magyar culture in the last part of the nineteenth century. Whether they ultimately succeeded or not, the assimilation process provided opportunities for the Jewish population to participate in the economic and social structure of Hungary. Szilard's family did exactly that, as his ample references to his "family connections" in Budapest affirmed. Szilard attended one of the Magyars' main vehicles of assimilation, the public schools. The opportunities afforded Szilard because of the nationalist aims of the Magyars, therefore, were important for his social and mental development. Through his family and the public schools, he became Hungarian. This did not mean that he or his family were ardent Magyar nationalists, only that his thoughts and values stemmed from those early educational experiences that were made possible and prescribed by Hungarian nationalism.

In addition, the conservative nature of the Hungarian upper classes allowed the Jews of Budapest to participate in the economic development of the city. Leading figures from the dominant social strata of Hungary displayed a

traditional disinclination to become industrial leaders and financiers; hence, in Budapest, as in Western Europe, the Jewish segment of the population moved into industry, finance and the other urban shopkeeping and professional positions. The Jewish population had "freedom" because of the acquiescence of the noble classes and the civil service gentry. The Jews had to be given freedom, and that gift, that recognition of "right," emerged from a society comfortably controlled by a ruling elite. Leo Szilard, educated in public schools and aspiring engineer, was a part of all of this, and the social conservatism of the time did as much to prescribe the parameters of Szilard's early life as industrialization, liberalism, or nationalism.

The success of Szilard's family and his wealth of "family connections" in Budapest illustrated the success of the Jewish industrial middle class in turn of the century Budapest. This was a surprising positive dynamic in the early life of Szilard and a problematic one. Anti-semitism never disappeared in Hungary, and the Horthy regime made great use of it. Szilard nevertheless seems to have been unaffected in his youth, and he left Budapest just as the ugliness of the Horthy terror began.

There are, of course, other possibilities, other dynamics that might be at play if we broaden our understanding of the historical dynamic involved in Szilard's early religious life. The influence of religion in

the life of Szilard might be represented by Szilard's participation in Jewish religious culture. Szilard's extended Jewish family and his early development indicate that Judaism may have played a major role in his intellectual development. Since Szilard described such an important role for his mother and the stories that she used to tell him, these stories might be seen as an indication of his religious upbringing:

> Very often it is difficult to know where one's set of values comes from, but I have no difficulty in tracing mine to the children's tales which my mother used to tell me. My addiction to truth is traceable to these tales and so is my predilection for "Saving the World." My mother was fond of telling tales to her children and she always had some particular purpose in mind. Why she wanted to inculcate addiction to truth in her children is not clear to me.[9]

Given this perspective, one might also expect that Szilard would have considered his religious upbringing as he recalled his childhood, but he did not describe himself or his mother's stories in this context in the "Recollections." Szilard did not consider his early life in terms of the social or intellectual structures or strictures of the Jewish religion. There were no references to the rituals of any religion or to belief in God.

Our historical presentation of Szilard fills this silence, nevertheless. The historical context of the story identifies Szilard's "Recollections" within a familiar historical hermeneutic by integrating and interpreting Szilard within those historical parameters usually

identified with the origins of modern society- industrialism, liberalism and nationalism. It also includes those structures antithetical to modern society- conservatism and religion. Within this dialectical historical framework, Szilard's "Recollections" represents the context of the development of modern society.

Szilard developed within a social structure determined by the industrialization of the late nineteenth and early twentieth century. This industrialization depended on the ideological environment of the liberal nation state. The modern state, committed to individual freedom, provided the proper environment for industrialization and, by inference, the science and technology on which that industrialization was based. Szilard's allegory of science and self, in this context, became a gesture that re-affirmed the necessary link between individual freedom and science- liberalism- and rejected a dogmatic social and philosophical hierarchy- conservatism and religion. In his allegory, Szilard encapsulated his and science's values in the phrases "addiction to truth" and "predilection for 'Saving the World'."[10] These terms seem to re-affirm a classical liberal and scientific concern with an Enlightenment-like truth that was manifest to all if one simply remained open to it, like an inquisitive child unfettered by the chains of intellectual old-age- dogmatism.

Despite this neat historical wrapping, an interesting contestation lingers in Szilard's allegory that cannot be explained by the traditional historical display of modernity. How is it that inquisitive, open-minded children or scientists innocently observe the world around them and interact with the environment in which they develop? According to Szilard's story, innocent children or scientists cannot escape the forceful nature of their molding surroundings, and children and scientists must be molded in a way that inculcates the importance of an inquisitive nature. This corruption of innocence must be limited so that a childlike nature can be maintained, but how does one, then, maintain the open-mindedness, the inquisitiveness of children or scientists while all around them forces seek to possess them physically and mentally?

If we examine the "Recollections" carefully, Szilard offered a formal answer that defied the usual juxtaposition of reason and faith in its description of modern science. In one stroke, Szilard identified both scientific values and the origin(s) of those values by encapsulating his "set of values" in the phrases "addiction to truth" and "predilection for 'Saving the World'." Addiction is usually defined as the quality or state of being devoted to something habitually or obsessively. Predilection signifies a prepossession in favor of something. By using these two words, Szilard indicated that his values were not something

to which one could be led to rationally. He did not describe his "set of values" as a process of coming to know truth. His "set of values" reflected a state of being dedicated to truth habitually- because of habit, custom, tradition- or obsessively- because of a persistent preoccupation. One came to know truth through habit or because of a preoccupation. In the same way, one prepossessed a tendency to "Save the World." It was not something which one rationally decided to do. Either you would want to do it, or you would not. It was not something which one would come to know as morally correct through reason. Both addiction and predilection precede truth and "Saving the World." You could not have the latter without the former, and the former involved an a-rational commitment to an object, a primordial attitude of being. Before all else one must crave truth.

While offering this prescription for scientific values, Szilard's story did not attempt to define the object of desire, truth. Within Szilard's "Recollections," truth displayed a dichotomous nature. There were those verifiable facts of our experience that can be reproduced for others, what Szilard called science. There were also moral truths, defined as truths about how one should act, agreed upon by all and manifest. For Szilard, both categories of truth were implied in his phrase "addiction to truth," and they were inseparable.

In addition, Szilard's notion of "remaining a child"

and his use of the words "addiction" and "predilection" suggested an *a priori* commitment to truth. One had to commit to an attitude of being before adopting or maintaining a childlike or scientific attitude which would lead to truth. Thus, the child and scientist were corrupted from the beginning because they must adopt a specific attitude to assert truth, and they could not arrive at truth independently of being addicted to it. Szilard implied the same understanding of truth in his phrase "predilection for 'Saving the World'." Predilection implied a primal attitude that preceded the recognition that one wants to save the world. One must feel the need or know that one must save- hold on to, retain- the world. This predilection did not supply a description of the object to be saved, nor a justification for itself. It was not from within the concept of the world that one found the origin of the attitude. The concept of the world and the idea of saving it were both preceded by a primal attitude and from this attitude sprang the notion of wanting to "Save the World." In the end, the rationality of the physical and the moral world depended on a prior a-rational commitment.

To explain his a-rational commitment to the maintenance of truth and saving the world, Szilard told yet another story in the "Recollections." This story stood in the place of any analytical explanation for the necessity of being addicted to truth and having a predilection for saving the

world. It also substituted for an attempt to locate the origins of these values in the intentions of his mother. His explanation, in other words, was the story.

In his "Recollections," Szilard told the story of his grandfather who was student assigned the task of monitoring his classmates when the teacher left the room:

> My grandfather, who was supposed to keep watch on disorderly children, joined those who left the school building and cheered the soldiers. When the teacher turned up for class, all the children were back in the classroom and my grandfather rendered his report. He gave the teacher the list of those children who violated orders and went out to the street, and this list included his own name. The teacher was so much taken aback by his frankness that nobody was punished.[11]

This could have been a typical children's story that reinforced the importance of extreme obedience to societal rules and superiors, even in the face of personal hardship, but this was not the lesson that Szilard learned. Szilard made it clear that frankness -honesty, addiction to truth- was the reason the teacher did not punish anyone.

Without Szilard's caveat it would be impossible to discern the motive of the teacher in rewarding Szilard's grandfather. How would one know if the teacher rewarded Szilard's grandfather because he had been frank or because he was exactingly obedient? How could one tell from this story the difference between strict obedience to an unquestioned principle and addiction to truth? What Szilard's story made clear was that this distinction could not be decided except by the author of the story. Here,

Szilard re-told the story and outlined his first principle; honesty or truthfulness would always be rewarded. Szilard was committed to the idea that childlike honesty would always be rewarded. There would never be any punishment for being honest, for being addicted to truth, for having a predilection for saving the world. Szilard's and science's values, as expressed in the "Recollections," began with this principle.

The logic and moral of Szilard's story made his principle clear. The grandfather (the scientist) was chosen to oversee the activities of others and to keep a list of things as they happened. Independent, but still a part of the class (society, nature), he frankly reported what he saw, even to the point of including himself in his observations. This self-inclusiveness, however, betrayed Szilard's grandfather (the scientist), because he no longer could say that what happened was not connected with him. He was not open and free any longer, because he was inextricably intertwined with an authority outside himself that had defined the reason for making the list. That authority was the teacher who was absent, but always present in the definition of the task and in requiring that Szilard's grandfather (the scientist) act in a certain way. Szilard's grandfather (the scientist) had to be frank and included himself in his list, and to be frank he (the scientist) had to be totally obedient to the task that had

been assigned to him, to the point of including himself in his observations. His grandfather (the scientist) was a slave to the unknown teacher that demanded his obedience and required him to be totally honest about what he saw. The teacher was never questioned in the story. The list was simply compiled, without the grandfather really knowing why-until the end, when the teacher returned and whimsically rewarded Szilard's grandfather for his honesty. In this final instance, both the purpose of the task and the reward was decided. The purpose of the task was to be honest, and reward was given on that basis. The moral to the story was that honesty will always be rewarded.

This simple morality, displayed through the story of Szilard's grandfather, betrayed a deep sense of Szilard's "frankness" by making explicit the fact that the *raison d'être* of Szilard's commitment to truth could not be known ahead of the act of being honest, of compiling the list, of being addicted to truth, of doing science. One must simply do it, as Szilard's grandfather did, and have faith that what one did would be rewarded.

In the "Recollections," Szilard often repeated this theme of "frankness" and coupled it with the "child-like" metaphor of his opening statement. For example, he recounted how he was "a favorite" of his classmates when he attended public school and attributed his popularity to the fact that he "somehow cut a favorite figure from the point of view of

the set of values which were prevalent at that time in the city of Budapest."[12] Here, he again related these values and his popularity to his "frankness," this time coupled with "lack of aggression."[13]

Szilard also described how he made a "strong impression" on his schoolmates by making the unique prediction that World War I would end with the defeat of the Austro-Hungarian monarchy, Germany, and Russia. He ascribed this remarkable prescience to an intuitive understanding of the political weakness of these countries and to his child-like mind which was not as emotionally involved as the minds of the adults around him:

> A man's clarity of judgement is never very good when he is involved, and as you grow older, and as you grow more involved, your clarity of judgement suffers. This is not a matter of intelligence; this is a matter of ability to keep free from emotional involvement.[14]

This portrayal of the pristine state of his youth, uncorrupted by emotional commitment, played on the notion of the child or scientist operating in an idealistic atmosphere and producing astounding observations and insights into the world or nature. Through these insights, the child or scientist made a strong impression on society, and society rewarded them for their openness and honest reflection. Here again Szilard had described the first principle of his child-like values and the values of an a-rational science imbued with moral principle.

All of Szilard's proverbial tales of himself and

science in the "Recollections" prescribed a categorical answer to the question of origin(s) quite different from the calm, manifest reason usually associated with science. Szilard's comprehension of himself and science conveyed a sense of a zealous, principled, almost religious attitude toward truth in which commitment to science came before truth and knowledge came from child-like revelation. Thus, his principled presentation of his and science's values in the "Recollections" described an unusual religious attitude toward science and displayed a certain religiosity, couched in the language of "addiction" and "prediliction."

Despite this apparent religiosity, Szilard did not mention God, the Jewish religion, or even his Jewish heritage in the "Recollections."[15] On these religious questions he remained explicitly silent. And yet he was not. In telling the story of his childhood, he described himself and science in terms of a devotion to truth and a commitment to saving the world, both of which echoed a kind of religiosity. In a seemingly contradictory way, Szilard retained religious "devotion" without maintaining a religious object as the focus of his or science's devotion.

All was not lost, however, in the crosscurrents of Szilard's allegorical gesture in the "Recollections." Szilard revealed another source for understanding the aim of his and science's devotion to truth:

> Apart from my mother's tales the most serious influence on my life came from a book which I read

> when I was ten years old. It was a Hungarian classic, taught in the schools, *The Tragedy of Man*. I read it much too prematurely and it had a great influence on me, perhaps just because I read it prematurely. Because I read it, I grasped early in life that "it is not necessary to succeed in order to persevere."[16]

This tragic principle bound the "Recollections" of Szilard's life together and played an important role in mitigating the dilemmas intrinsic to Szilard's presentation of himself and science in the "Recollections." Szilard's answer to the question of how one knew that honestly observing the world would always be rewarded was that one did not know and cannot know. Indeed, one will not always be rewarded, but one could persevere or persist in a state, enterprise, or undertaking in spite of counter influences, opposition, or discouragement.

This was his and science's tragedy according to Szilard. We cannot know that the child or scientist will not be corrupted. Nevertheless, we persevere to maintain our childlike or scientific attitude. We cannot know that our all inclusive "frankness" is nothing more than dogmatic obedience, but we must persevere. We cannot know that honest observations of the world--science--will always be rewarded, but we must persevere.

This tragic presentation of science represented a kind of religious devotion without a religious relic. Szilard's "Recollections" shifted the question of origin(s) from one of location--space, time, group, intellectual category--to

one of moral imperative and asked the reader to confront *The Tragedy of Man*. To do so would not necessarily be a pointless exercise, because, with Szilard as our guide, "tragedy" appeared at the center of the question of the origin(s) of Szilard and his science. Traces of *The Tragedy of Man* "prematurely" affected Szilard as a child, and this suggested a supplement to our understanding of Szilard and science that included "tragedy" as an important concept within a representation of Szilard and his science, even if that understanding could not be punctuated except by an ellipsis.

Notes

1. Leo Szilard, "Recollections," 3 in *Leo Szilard: His Version of the Facts*, Spencer R. Weart and Gertrude Weiss Szilard, eds. (Cambridge, Mass.: The M.I.T. Press, 1978). Hereafter cited as "Recollections."

2. If we take Szilard at his word, then our story can begin with a further question. What about the origin of this understanding of Szilard and science? Szilard would have us believe that in understanding the essence of his idea of science, we will comprehend Szilard and science, but is this really the beginning, the origin of Szilard and science? Is not the historian obligated to seek the origin(s) of this metaphor, to explain Szilard's scientific reference by locating Szilard in space and time? Is it not here that the "historical" hunt begins, ends, and, through historical facts, displays Szilard? If so, then let us begin with a description of the facts surrounding the birth of Leo Szilard.

3. Paul Ignotus, "The Hungary of Michael Polanyi" in *The Logic of Personal Knowledge* (London: Routledge and Kegan Paul, 1961): 4.

4. George Barany, "Magyar Jew or Jewish Magyar," *Canadian American Slavic Studies* 8, no.1(Spring, 1974): 27

5. In the Budapest of 1910, the center of Hungarian industrialization, Jews made up 52.5% of all people engaged in industry, 64.5% of all people engaged in finance and trade, 58.8% of all medical personnel and 61.5% of all people practicing law. Arthur J. May, *The Hapsburg Monarchy, 1867- 1914* (Cambridge, Mass.: Harvard University Press, 1951): 363; William O. McCagg, Jr., *Jewish Nobles and Geniuses in Modern Hungary*, East European Monographs, III (Boulder Col.: East European Quarterly, distributed by Columbia University Press, 1972): 30.

6. This Jewish middle class has been characterized by some as a "service bourgeoisie" to the Magyar nationalists, and by others as an "influential foreign colony . . . not hostile, and in many aspects of value to Hungary, but lacking comprehension of Hungarian life and ways." Oscar Jaszi, *The Dissolution of the Habsburg Monarchy* (Chicago: University of Chicago Press, 1929): 173-175; Denis Sinor, *History of Hungary* (London: George Allen and Unwin Ltd., 1959): 276.

7. Tristram Coffin, "Leo Szilard: The Conscience of a Scientist," *Holiday*, 35 (Feb., 1964): 94-95.

8. Szilard, "Recollections," 3-8.

9. Ibid., 3

10. Ibid.

11. Ibid.

12. Ibid., 4.

13. Ibid.

14. Ibid., 5.

15. Szilard did not express his religiosity in terms of religious practice or belief in God. Szilard's religiosity, therefore, cannot be comprehended by reducing his religiosity to a particular religious affiliation. Such a reduction would simply emphasize the necessity of the non-religious in Szilard comprehension of himself and science and offer no insight into why Szilard considered "addiction" and "predilection" to be so important. In addition, it would reiterate the importance of the negation of the religious category in the modern historical matrix without offering any insight into the origin(s) of Szilard's or science's devotion to "frankness" or honesty. The question of the origin(s) of Szilard's principled attitude as represented in the "Recollections" would still remain.

16. Ibid., 3.

CHAPTER TWO
TOWARDS AN UNDERSTANDING OF LEO SZILARD'S SCIENCE: IMRE MADACH AND TRAGIC SCIENCE

In his "Recollections," Szilard's conveyed an understanding of himself and science in terms of his "addiction to truth" and his "predilection for 'Saving the World'." The religiosity of this description of science had the effect of placing scientists in the paradoxical situation of having to believe in rationality before the world could become rational.[1] Szilard's science did not have its own rational justification, but Szilard did not apologize for this religiosity. He only said "it is not necessary to succeed in order to persevere," characterizing his and science's values in tragic terms that explained everything in their brevity. The fullness of meaning contained in this tragic admonition will be explored in this chapter by examining science in the tragic context that Szilard offered in the "Recollections," Imre Madach's *The Tragedy of Man*.

Szilard's reference to *The Tragedy of Man* and his tragic characterization of life were not confined to his "Recollections." As will become clear below its influence extended throughout his life. He counseled in a piece from 1940 called "Ten Commandments" to "Let your acts be directed

towards a worthy goal, but do not ask if they will reach it."[2] In an interview conducted in 1945, he acknowledged a similar sense of the tragic and again invoked Madach's *The Tragedy of Man* when queried about the problems of atomic energy and the bomb:

> When I was a boy of 10 . . . I read a novel called 'The Tragedy of Man' by Madach, which influenced my whole life. In that book the devil shows Adam the history of mankind, with the sun dying down. Only the Eskimos are left and they worry chiefly because there are too many Eskimos and too few seals. The thought is that there remains a rather narrow margin of hope after you have made your prophecy and it is pessimistic. That is exactly the situation in regard to the atomic bomb. We must concentrate on that narrow margin of hope.[3]

Here one can see clearly the thematic importance and chronological continuity of Szilard's signification of himself and science as tragic and hear the echoes of God's final words to Adam in Imre Madach's *The Tragedy of Man*:

> **The Lord** to Adam:
> Hark to Me, Man! Strive on, strive on, and trust!

If we are to understand Szilard's "tragic science," then we must examine carefully the way in which Szilard's use of these final words emerged from the critical tradition that has sought to understand the Lord's final admonition to Adam in *The Tragedy of Man*.

Madach's Tragedy was a dramatic poem consisting of fifteen scenes. It began as a conversation between God and Lucifer in which it was decided that Lucifer shall have his corner of earth, the trees of knowledge and life. Lucifer accepted this meager foothold for his kingdom of negation

and vowed to use it to destroy the world of the Lord. The conversation between the Lord and Lucifer set the stage for the fall of Adam and Eve, who chose to eat of the trees of knowledge and life. Thrown out of Eden, Adam and Eve began a life on and of the earth, a life of youthful curiosity about nature and about the purpose of Man's toils on earth.[4] When Lucifer asked Adam to be patient in his quest for knowledge, Adam replied:

> That is the retrospect of one grown old,
> And not the object of my ardent youth.
> I long to look into my future life,
> To know for what I have toiled and why I suffer!
> **Eve**
> And I would know if, in all those revivals,
> My charm and beauty will not fade and wane!
> **Lucifer**
> So be it. I will cast a spell on you;
> And, in the visions of a drawn-out dream
> Your far-off future ye shall clearly see.
> And when ye see how vain it is to strive,
> How hard the fights ye'll fight upon your way,
> Lest ye should lose your courage and, like cravens
> Be tempted to desert the field of battle,
> A tiny ray I'll set amid the skies,
> To cheer you and to tell you all ye dreamt
> Was mere illusion. In that ray take Hope![5]

After comforting Adam and Eve with this illusory hope, Lucifer then took Adam and Eve on a journey through future history, beginning with ancient Egypt and ending with the nightmarish vision of the cold desolate world of the Eskimo, which Szilard so vividly recalled as he pondered the fate of an atomic world. In each of the scenes Adam and Lucifer became a particular character of the times--a pharaoh, an emperor, a scientist (Kepler), a French revolutionary (Danton)--and they held an eternal conversation that was

renewed in each particular historical setting. Eve appeared in all the scenes and also became a character of the times, although her identity as Eve was often hidden from Adam until Lucifer felt it was appropriate that her identity be known.

In this manner, the dream visions were played out, and in each scene Adam was forced to confront the knowledge which he sought, until he was finally confronted with a desolate world dying from the heat death envisioned by nineteenth century thermodynamics. So overwhelmed was Adam by this vision, by this final disillusionment, that he contemplated suicide. At the last minute, however, Eve informed Adam that she was with child. This revelation moved Adam to appeal to the Lord for forgiveness, but his quest for knowledge did not leave him:

> **Adam**
> O, Lord! Appalling visions have distressed me.
> I know not what is true in them, or false!
> Ah, tell me, tell me now what fate awaits me.[6]

The Lord then told him that it was better that he not know because it was only in his <u>not knowing</u> that his struggle remained a virtuous one. The Lord explained that if Adam knew that there was or was not eternal life after death, then he might not struggle for his high ideals. Therefore, Adam must remain ignorant about his fate if "greatness" and "virtue" were to be maintained, and he bid Adam and Eve to struggle and trust: "Hark to Me, Man! Strive on, strive on, and trust!"

The story of Madach's tragedy, told in brief here, recalled other romantic dramas of the nineteenth century, especially Goethe's *Faust*. The character and predicament of Adam echoed Adams Faustian father, as many critics have been quick to point out. The language and themes of the play mimicked this literary ancestry.[7] Equally unanimous, however, has been the critical view that Madach's *Tragedy* should not be considered simply a pale copy of Goethe's work. It offered its own tragic vision related to, but not encapsulated by Goethe's *Faust*.[8]

Madach's Adam was a younger, less repentant Faust tied more closely to Lucifer and "the earth bounded nature of his will to know all and to be free to pursue it [wisdom]."[9] Lucifer was in many ways a more potent Mephistopheles who, according to one critic, merged more with the human character, while maintaining his part as an "original element" of the universe. This made Madach's Lucifer a "dialectical antithesis to God the ruler" and signified Madach's more dialectical vision of tragedy as opposed to Goethe's "three dimensional" characterization of tragedy.[10]

Madach's Eve was also quite different from Faust's Margareta. While Eve still represented the manifestation of the ideal in the world and the generative force of nature, as a character, she was more idealized, according to one critic.[11] These characteristic differences have outlined a critical consensus that the great works of Goethe and

Madach, although related, were conceived and should be conceived of differently.

Beyond this there has been little critical agreement on the tragic father of Madach's tragedy. While critics have conceded that Goethe's *Faust* was the grandfather of Madach's tragedy, *The Tragedy of Man* had many fathers. First there was the historical father, Hegel and his "Vorlesungen über die Philosophie der Weltgeschichte." *The Tragedy* had a strong sense of the dialectical movement of history as enunciated by Hegel. Some commentators have even gone so far as to outline the fifteen scenes of the play in terms of the Hegelian dialectic between the altruistic and the egocentric.[12]

But most have noted that the phalanstery scene of the play, in which Adam confronted the stifling monotony of a socialist state, reflected Madach's ultimate rejection of Hegel's belief that the spirit of the individual can only emerge within the framework of the collective state and showed that Madach was quite skeptical of the idea of the liberation of the individual through the collective state. Madach's state, as represented in the phalanstery scene in *The Tragedy of Man*, reduced all individuality and creativity to dull sobriety, scorned Luther, Cassius, Plato and Michelangelo, and sought to destroy even the most precious of individual relationships, that between mother and child. In this scene, Madach's Adam could not bear it as he watched

the state take away Eve's child, and he proclaimed his love for her. When the aged men of the collective society greeted his love with contempt, Adam replied:

> Nay, do not pity us.
> This madness is our own.
> We do not envy Your dull sobriety.

This depiction of the state and the final lines of the play, which offered no final resting place for the liberation of the individual, especially not a state, punctuated the difference between Madach and Hegel.[13]

The ambiguity of *The Tragedy of Man* has led one important commentator to point out that it was not Hegelian history that drove the drama as much as the "human urge for liberty."[14] Dieter Lotze has suggested that *The Tragedy of Man* should be thought of as a part of a larger European literary movement which grew out of the clash between a dying romanticism and an emerging positivism in the middle of the nineteenth century. Lotze and other scholars have identified this literary genre as the *poème d'humanité* or *Menschheitsdichtung*. This poetic movement sought answers to the question of "man's purpose on earth" through its attempts "to show in dramatic or epic form the development of mankind through one or more of its outstanding representatives."[15] Lotze suggested that Madach's *Tragedy* was a "realization" of the "potentialities" in this poetic movement. In particular, Lotze identified Victor Hugo's *La Légende des siècles* as the work most "parallel" to

Madach's.[16] Ultimately for Lotze, these two works were joined philosophically by their preoccupation with "humanity" struggling to maintain freedom and progress in a world of religious, political and economic constraints.[17]

Nevertheless, the differences between the two works remained significant for Lotze. Madach's work was more uniform in style and more realistic. It maintained a central hero instead of thematic unity and tended to concentrate on "great historical personages" much more than Hugo's work. It maintained a dialectical historical structure as opposed to the diffuse structure of Hugo, and the context of Hugo's work was much more explicitly related to Hugo's native country than was Madach's *Tragedy*.[18] Hugo often referred to France and French History. Madach's *Tragedy* had only one Hungarian reference.[19] These dissimilarities indicated, according to Lotze, that Hugo's *Légende* and Madach's *Tragedy* should be thought of as exemplary relatives in the family of the *poème d'humanité*, and not as literary father and son.[20]

This literary discussion of the Hungarian nature of Madach's *Tragedy* has circumscribed the philosophical heritage of the work. The *poème d'humanité* has usually been represented as the product of the philosophical conflict between romanticism and positivism. As a *poème d'humanité* then, Madach's *Tragedy* lies somewhere in the crosscurrents of these philosophies. Many commentators on the *Tragedy* have noted the way in which Madach criticizes positivism, but

perhaps the most thorough examination of Madach's critique of positivism can be found in the work of Mihaly Szegedy-Maszak. Szegedy-Maszek has argued that the entire dialogue between Lucifer and Adam in the *Tragedy* "was nothing but the projection of an inner debate between the teleology of romantic liberalism and the cyclical life-conception of positivism."[21] Furthermore, Szagedy-Maszak has contended that the positivist state portrayed in the phalanstery scene indicated Madach's fear of the realization of a positivist, scientific technocracy.[22]

The *Tragedy* was, in this view, a critique of positivism similar to that of Nietzsche and Bergson. Szegedy-Maszak noted that the absence of God throughout the play has been used by many critics of the drama to argue that the *Tragedy* expressed the irreligious pessimistic view of positivism. The positivist world ran in a self-contained, never ending cycle, and God was little more than a complacent handicraftsman or a Spencerian "symbol of the restrictions of cognizance."[23] According to Szegedy-Maszak, Madach did not relegate God to such an inconsequential role. Instead, Madach's dialogue between Adam and Lucifer showed how Madach thought in terms of a continuous dialectic of thesis and antithesis, but without synthesis.[24] Madach's pessimism lay in the fact that he thought of Lucifer (or negation) as "an inalienable attribute of God." This was far different from denying the importance of God or of religion. Certainly it

was not traditionally Christian, but it did not eliminate the daily importance of God. That importance was merely transferred into purposive activity--striving after that being which has set the purpose of my existence.[25] God was present in his absence because He gave purpose to our striving, and Lucifer, through his negation, served as guide for our progress. In denying negation, we were able to realize progress. This view of God and striving man, with its emphasis on action inseparable from purpose and thought, according to Szegedy-Maszak, illustrated how Madach's *Tragedy* was a "forerunner of Nietzsche's criticism of positivism."[26] Madach did not, however, offer a way to transform values. There was no *Wille zur Macht* in Madach's *Tragedy*--only the ambiguity of striving and the problematization of all metaphysical systems, including positivism, and therein lay its "tragic" nature.[27]

Critical recognition of Szegedy-Maszak's "tragic" nature in Madach's play has led to a analytical choice when interpreting the *Tragedy*. One is forced to describe Madach's drama as "salvation or tragedy?"[28] The sociological explication of Dieter Lotze has led to the consideration that the play represented in some sense "post-revolutionary Hungary." This explanation of the play encapsulated "the tragic" in a political and personal response by Madach to a particular time in Hungary. This political comprehension of the *Tragedy* has had the effect of defining the *Tragedy* in

terms which are not tragic. That is, it defined tragedy in terms of a particular cultural system in which the *Tragedy* can be said to have rested, thereby freeing the reader to respond to the *Tragedy* as something other than tragedy and as offering salvation of one kind or another. It could be the salvation of the Hungarian state that can be found in the Lord's final admonition, or it could be a form of reassuring religious salvation. In either case, the *Tragedy* was not really tragedy, but salvation, and the tragic ambiguity of the *Tragedy* was only apparent, and not real. It was and is only a mirage of Madach's times.[29]

Or the *Tragedy* was really "tragedy" and rejected any metaphysical system which has been offered as salvation from the ambiguity of time, including a sociological explanation for "tragedy." That is, the *Tragedy* offered no respite in "post-revolutionary Hungary" or any other temporal framework when it came to defining or finding man's purpose here on earth. Each time, or rather, each scene had its own legitimacy, its own meaning, and tragically we can only accept God's final admonition to strive on in a world devoid of meaning and "shoulder the full burden of the anxiety of meaninglessness."[30]

Thomas R. Mark, in his article, "'The Tragedy of Man': Salvation or Tragedy?", has explored this "tragic" argument and criticized Hungarian interpretations of the *Tragedy* for not "facing the tragic as tragic" and substituting "some

kind of vision of an ultimately benign cosmic order."[31] Mark has argued that both salvationist readings reflected an unwillingness on the part of most critics to see the play in its proper "tragic" form, and an unwillingness to confront the "Eskimo Scene."[32] This scene was, after all, the "final" vision of Madach's "future history" and cannot be left out without transforming the *Tragedy* into something other than "tragedy." This, according to Mark, was a "tragic" mistake.

The context of this debate is important for understanding the position of Madach's representation of science in *The Tragedy of Man*. As Mark so eloquently pointed out, scenes eight through fourteen of the drama explicitly critiqued "science and the social hopes founded on it."[33] In scene eight, Adam was reincarnated as Kepler, and Lucifer was Kepler's assistant Famulus. Kepler (Adam) was a man who struggled with the new knowledge of science in an age of superstition and religious darkness and dreamed of a time when the ideals of science would be "the anthem of the Future," "the mighty talisman, That will restore the youth of this old Earth!"[34] Scene nine was that dream within a dream, as Adam became Danton in the French Revolution. Here Adam, as Danton, faced the realities of his dream and became a casualty of his own dream when the angry mob crushed all those that stood in the way of Liberty. In scene ten, Adam, as Kepler again, awakened from his nightmare, but he was not disheartened. He said of the mob:

> How great, how glorious were their crime and courage,
> And how amazing both did seem to be--
> For Strength had set its seal upon them both.
> Ah, why did I awake, if 'twas to see
> More clearly all the squalor of the age,
> That hides its sins behind a smiling face,
> And owes its virtue but to force of habit![35]

He then encouraged a student who longed to gain the knowledge of nature that his master possessed, but Adam/Kepler told him not to look for knowledge in schools and books:

> Take, then, these old and rotting yellow parchments, These mouldy folios, overlaid with dust,
> And throw them into the fire. For they prevent us
> From standing, as we should, on our own feet,
> And only spare us the fatigue of thinking.
> They bring the errors of times past and dead,
> As superstitions, into our new age.
> Into the Flames with them! And let us go
> Where we shall find the open air of Heaven![36]

Kepler's manifesto of experimental science, so scornful of book learning, set up the last scenes as a critique of the ideals of science.[37] Madach's references to science in the final scenes of *The Tragedy of Man* offered an explicit understanding of "the tragedy of naturalism."[38] In the London scene, Adam and Lucifer appeared at a fair in a future industrial society guided by the philosophy of individualism and competition. Each person in this society was left to his or her carefree nature, and high ideals ignored in the pursuit of individual gain. Scholars were manufacturers, and Eve, the ideal of beauty, was a middle-class woman committed to the trappings of wealth and status.

In this society The Quack spoke for science:

The Quack
Make way, make way, make way! And feast your eyes
On me, a man grown grey because he's wise!
The secrets Nature had so long concealed,
Thanks to my tireless labor, she's revealed!
Adam
What is that crack-brained creature, Lucifer?
Lucifer
Science itself, which lives by quackery...
Just as it did when once thou was so learned.
But now it has to cry its wares more loudly.[39]

One should not conclude from this presentation of science that Madach believed science was quackery. He was merely representing the character of Kepler in this different time. Even in this future, technological age, Kepler's insightful science had not found its proper respect. It was, therefore, confined to practicing what the people wanted in order to survive, just as Kepler had been forced to practice astrology in order to pay his bills. Furthermore, Kepler, as the Quack, was no more appreciated in this time than he was in his own. In this society the scientist had become a tiresome old peddler of wares whose miraculous knowledge seemed empty, and who had lost the sense of importance that made Kepler so great and his vision's of a scientific world so grand. The order and grandeur of science had been lost in the chaos of individuality.

This moved Adam to dream of a different scientific society:

> Instead, I dream of a Community,
> To guard, not punish, to inspire, not check,
> Endeavor, by a great Co-operation,
> Such as the Mind of Science could conceive
> And o'er whose Intellect would watch.
> 'Twill come some day, I feel, I'm sure, I know...
> Oh, Lucifer, now lead me to that world![40]

Lucifer obliged Adam, and they moved on to a phalanstery. Here science was the "honoured sentinel," "watching over life's soft-flowing course."[41] Adam and Lucifer, in the garb of the phalansterists, conversed with a busy scientist. The Scientist was a chemist who espoused a deterministic, materialistic philosophy of science.[42] Science, according to The Scientist, had domesticated all animals and plants on earth, disposing of the inefficiency of "bungling Nature" in the process.[43] This had enabled science to provide a comfortable material existence for all. Science had also done its best to do away with the "play-things" of Man's past, such as poetry, literature and art, which had wasted so much of the strength of Man and contained a poison that moved men to activities that upset the order of the community. For example, the "fairy-songs," which used to warm the hearts of children, had been replaced by "higher equations and geometry."[44]

Adam, soon disenchanted with this heartless world devoid of life and individuality, sadly lamented:

> So Science, too, has disenchanted me.
> To me it seems a dull and childish school,
> And not the happy field I had expected.

The Scientist objected and asked Adam if brotherhood had not

been established by providing for man's material needs. Adam, however, remained skeptical of the "uniformity" of The Scientist's scientific society and asked about the source of that uniformity. The Scientist explained that the guiding principle of this scientific society was that all people should have enough to live on. The aim of the scientific society was to stop the wasteful use of the earth's natural resources that was so prevalent in the times of "romantic theories" and poetry. There was little time to waste in this scientific endeavor also, because:

> Within four thousand years the sun will cool,
> And there will be no vegetation left
> On Earth. But those four thousand years are ours,
> To seek a substitute for the sun-rays!
> That should be long enough, methinks, for Science.[45]

With that explanation, The Scientist returned to his alembics, and watched in anticipation as his chemical experiment to transform matter into organic life began to stir:

> **The Scientist**
> See! See thou! How it surges! How it flames!
> Look! Here and there are hazy forms that stir,
> Pent up within this hot and well-closed glass.
> The chemical affinities and reactions
> All tally, and ere long we'll find that
> Matter will be compelled to do what I have willed.[46]

Lucifer, impressed by this feat, asked The Scientist for the basis of his knowledge, and he replied that "It is a law, that's all."[47] Lucifer then ridiculed The Scientist's answer and called him "Nature's stroker."[48] Adam also declared The Scientist ignorant of the "spark" of life and in that

instant, as The Scientist's experiment exploded, The Spirit of the Earth proclaimed of the holy secret of life: "No man will ever take it!"[49]

As The Scientist turned, nevertheless, to begin his work again, he was interrupted by a tolling bell signaling the end of the work day, and a parade of those who had been derelict in their duty to the phalanstery began. Luther, Cassius, Plato and Michelangelo were called forth and castigated. Eve was brought forth with her child, and The Aged Man of the phalanstery ordered that Eve's child be taken away from her. Eve cried out in horror, and Adam spoke out on her behalf, proclaiming his love for her. For this emotional outburst, he was repudiated by The Aged Man and The Scientist who decided:

> A romantic man and a nerve-ridden women
> Beget weak offspring. They're unfit to mate![50]

The horror of this situation and this scientific society moved Adam to cry out that he be taken away from the earth "to loftier sphere." Lucifer complied, whisking himself and Adam off into space (scene thirteen).[51] He did not want to see this world of science anymore.

The critique of science in this scene aimed directly at a "science" that portrayed itself as <u>the</u> spokesman for wisdom and values in society and reduced value to material reality, just as it sought to comprehend life in matter. This materialistic science had lost its ability to reflect

upon itself. Laws had replaced wisdom, and, in the end, science had nothing to say about the purpose of life. Its only vision was one of thermal death, rigorously established by scientific law.

Adam sought refuge from this scientific mind as represented by the collective society of the phalanstery, and he and Lucifer flew off into space. Now separated from the earthly world, Adam cried out his defiance of his earthly body. He declared to The Spirit of the Earth:

> Yet I defy thee! And I fear thee not.
> My body may be thine--my soul is mine!
> For thought and Truth I know are infinite!
> They were long, long before thy world of matter![52]

Solemnly, The Spirit of the Earth reminded him that he could not survive without Him and that "All Beauty, Ugliness, all Heav'n and Hell, Are but expressions of my living Spirit."[53] Adam, realizing his predicament, remained defiant and proclaimed the immortality of his soul, just as he was snatched back from death at the last minute by Lucifer.

Despite all of this, Adam did not forsake science at this point in the *Tragedy*. He did not give up on science and its hopes of enlightenment and progress. He merely stated that now he understood that value and purpose had to be an integral part of the enlightenment and progress of science. He believed this despite Lucifer's reminder of the words of The Scientist:

> Hast thou forgot what said The Scientist?
> Four thousand years or so from now, maybe,
> The world would freeze, the struggle would be

over?

Adam

Provided that our Science won't forestall it.
But I feel, yea I know that Science will.[54]

Adam's response displayed the confidence that Adam had in the power of science. He recognized the limitations of a materialistic science and believed that conception of science would fade away. But "the Idea, which gave it [science] life, again will rise triumphant."[55] Adam still longed to see what new idea would arise to inspire Man, and he remained optimistic about a future scientific world that transcended the collective dogma of materialism.

In the end Adam's idealistic science did not triumph in *The Tragedy of Man*. Lucifer showed Adam the fate of mankind four thousand years in the future. It was the world as prophesied by The Scientist, a cold desolate world peopled by only a few Eskimo who fought over the remaining seals. Lucifer mockingly noted:

We are here now. That red ball is thy sun.
Beneath our feet there lies the Earth's Equator.
So Science has not triumphed over Fate![56]

Adam was stunned by it all and cried out in anguish:

Was't struggling bravely, in a noble way,
Or miserably, waning more and more,
Devoid of greatness, worthy of no tears?[57]

It seemed not, as Adam, reincarnate as an old broken-down man supported by a staff, spoke to one of the Eskimos. The Eskimo told Adam of his disenchantment with the gods and his anger at having to struggle to exist even for a day. He then pleaded to Adam: "Oh! If thou art God, I beg of thee, let us

have fewer men, And send more seals!"[58]

The heartless appeal of the Eskimo in this final scene displayed how the thermal death so accurately predicted by science had killed science's own hope of a fraternal society. In its own truth science had destroyed Man and all the noble values which it had proclaimed for itself. Even idealized Eve has been transformed in this deterministic scientific vision to a mere "beast."[59] Madach had shown "the tragedy of naturalism" through the realization of its inescapable materialistic vision. Science, in basing itself on the laws of nature, could not escape itself and doomed Man to its lawful vision. Man, in the end, became the inert matter with which science comprehended all things. Lucifer had shown Adam the idea of science, just as he had wished.

This tragic characterization of science and the vision of science in Madach's *Tragedy* outlined a "tragic science" that retained both meaning and ambiguity. In the final scene The Lord/Madach did not offer a falsification of the Adam's visions of science, especially his vision of a world dying of thermodynamic heat death. The Lord/Madach only showed Adam the juxtapositions of life which made it tragically meaningful--death (Adam's thoughts of suicide), birth (Eve with child), Good (God), Evil (Lucifer)--and admonished Man to strive to make life meaningful. These final words of God were an admonition to tragic man who could not escape the always already present questions of the meaning of life. The

tragic man must always strive for knowledge because it was only in that process he/He became meaningful. This process defined "tragic science," and tragic man had to do it in order to make life meaningful. So sayeth The Lord: "Hark to Me, Man! Strive on, strive on, and Trust!"[60]

Leo Szilard concluded that: "It is not necessary to succeed in order to persevere." By his own admission Leo Szilard learned this tragic lesson from Imre Madach's *The Tragedy of Man*. This principle formally served the same purpose within Szilard's presentation of himself and science as it did within Madach's *Tragedy*. Szilard recognized the ambiguity of the meaning of life and tragic man's necessary pursuit of knowledge. This a-rational telic principle of tragic man could not be found within the rationality of science, but when it was coupled with science, a "tragic science" emerged that called for persevering toward knowledge, but did not define itself in terms of epistemological certainty. Its purpose came from The Lord's tragic admonition and its tragic nature from Adam's youthful longing: "I long to look into my future life, To know for what I toil and why I suffer!" As a tragic scientist, Leo Szilard retained Adams childlike curiosity and was born a scientist:

> As far as I can see, I was born a scientist. I believe that many children are born with an inquisitive mind, the mind of a scientist, and I assume that I became a scientist because in some

ways I remained a child.[61]

The voice of Madach's Adam echoed in this childhood reference to himself and science. He was the tragic man born with Adam's need to know, and from his dream-like "Recollections," just as from Adam's visions, "tragic science" emerged, always in pursuit of Truth and guided in its always ambiguous undertaking by the admonition of The Lord:

Hark to Me, Man! Strive on, strive on, and trust!

Notes

1. Religious here means a prior, a-rational commitment.

2. Leo Szilard, "Ten Commandments," in *Leo Szilard: His Version of the Facts*, Spencer R. Weart and Gertrude Weiss Szilard, eds. (Cambridge, Mass.: The M.I.T. Press, 1978).

3. Leo Szilard as quoted by Oliver Pilat, "Let's Share Atomic Energy," *Weekly Picture Magazine* of the *New York Post* (Nov. 24, 1945).

4. Please note that I have used "Man" here and will continue to use it and "Mankind" throughout my discussion in this chapter. I will do this because I think it is necessary in order to highlight the masculinity of Madach's *Tragedy*, of science as it is portrayed in the *Tragedy*, and of "tragic science" which so closely identifies itself with the character of Adam.

5. Imre Madach, *The Tragedy of Man*. Trans. by J.C.W. Horne (Budapest: Corvina Press, 1963): 51-52. This is the translation that will be referred to throughout this chapter.

6. Ibid., 296.

7. See Dieter P. Lotze's chapter entitled "The 'Hungarian Faust'? Madach and the Faust Tradition" in his *Imre Madach* (Boston: Twayne Publishers, 1981), for perhaps the best summary of Madach's Faustian roots.

8. George Bisztray, "Man's Biological Future in Hungarian Utopian Literature," *Canadian-American Review of Hungarian Studies*, 3 (1976): 4.

9. Esther H. Leser, "A Hungarian View of the World, Expressed in a Faustian Tragedy: Some Considerations upon Madach's *The Tragedy of Man*," *Canadian-American Review of Hungarian Studies*, 5, No.2 (1978): 47-48. Jane K. Brown in her article entitled "Faust" in *European Romanticism: Literary Cross-Currents, Modes and Models*, Gerhart Hoffmeister, ed. (Detroit: Wayne State University Press, 1990): 194, implicitly does not agree with Leser's and others' assessment of Adam as being younger than Faust. She argues that in the late romantics, which included Madach, Adam resists the pact with the devil, and this transforms the Faust story and makes Faust into "an older and wiser Adam." This only makes sense if one defines "older and wiser" as more cynical and less trusting of anyone and anything, especially the devil. Leser perhaps would agree with this, but thinks of Adam as younger because he is <u>also</u> more cynical and less trusting and respectful of God. The same attitude, it seems, is young and unwise if one is speaking about Adam's relationship to God, and old and wise if it is the relationship to the devil. In any case, Adam seems to have quite an attitude problem, more so than Faust.

10. Leser, "A Hungarian View of the World," 46-47. Gerald Gillespie's comparative analysis of "The Devil's Art" in *European Romanticism* seems to confirm this understanding of Madach's Lucifer. He comments on Madach's tragedy in the following way: Madach's *The Tragedy of Man* is "another extraordinary work using the basic Goethean outline . . . . The 'open' ending, the mandate to endure, scarcely mitigates the horror of the perceived slice into a soulless future emptied of values...developmental hope is muted....The devil, who elaborately demonstrated his archetypal relationships with the range of myth in Goethe's *Faust*, tended to disappear again into the web of allusions and motifs that became standard elements in the repertory of modern writers." See pages 94-95.

11. Jane K. Brown, "Faust" in *European Romanticism*, 192-93.

12. Charles Wojatsek, "The Philosophical and Ethical Concept of the Tragedy of Man." *Etudes Slaves et Est-Europeennes*, 6 (1961): 214.

13. Dieter Lotze in *Imre Madach* has suggested that perhaps it is not the Hegelian dialectic that we should perceive within *The Tragedy of Man*, but that of Karl Marx. He says that after the Paris scene, "Madach seems to move closer to Marx than to Hegel. The focus is no longer on individual

consciousness but rather on societal structure." See pages 84-85. He adds later on: "What separates him from Marx is his negative view of the society of the future and his Hegelian interpretation of history as theodicy."

What has to be noticed is that Madach wrote tragedy. Hegel and Marx did not. Madach may have used historical dialectic, but he does not comprehend mankind through dialectic. He offers tragedy, and tragedy has no final resting place in the *Volkgeist* or in the utopian communist state.

14. Ibid., 140. Here I will be following the argument of Dieter Lotze in Chapter Six of *Imre Madach*. His work, as he states explicitly, is founded on the dissertation of Eniko Molnar Basa, "*The Tragedy of Man* as an Example of the *Poème d'Humanité*," University of North Carolina, 1972.

15. Ibid., 130.

16. Lotze has noted that Madach belonged to "the generation of Hungarian writers after 1830 for whom revolutionary France had become the cultural ideal," and he discussed the many thematic and structural similarities between the two works. Ibid., 137-140.

17. Ibid., 139-140. "In both works there is a continuous disillusionment but also some progress, and both writers see the human urge for liberty as a driving force." See page 140.

18. Ibid., 140-142.

19. The only explicit Hungarian reference in the drama is a brief allusion to Hungarian general Janos Hunyadi who conquered the Turks.

20. Lotze's generic understanding of Madach's *Tragedy* emphasized the nationalistic uniqueness of Madach's tragedy within the European family of the *poème d'humanité*. The necessity of this nationalistic qualifier explained the tendency of many critics to label the drama primarily a "Hungarian" play. This play, according to most critics and Hungarians, represented what was meant by "Hungarian" in the middle of the nineteenth century. This latter statement was almost taken for granted by every critic who wrote about the play. Esther Leser writes of the "Hungarian mental climate" and the "Hungarian *Geist*." (See Leser, "A Hungarian View of the World," 43.) Alexander Hevesi identifies Madach's starting point as "the national struggle and agony of the fifties." (See Alexander Hevesi "Madach and 'The Tragedy of Man.'" *The Slavonic and East European Review*, 9 (1930): 401.) These are just a few of the many ways that critics

related Madach's *Tragedy* to "Hungary." Even the absence of any references to Hungarian history served as proof for most Hungarian writers that the play is about Hungary. Mihaly Szegedy-Maszak says of Madach's intent in writing the play: "By adopting the common symbolics of mankind and leaving national references out, Madach raised the Hungarian tragedy of his age on the level of national existence." (See Mihaly Szagedy-Maszak, "Life-Conception and Structure in 'The Tragedy of Man.'" *Acta Litteraria Academiae Scientiarum Hungaricae*, 15 (1973): 327.)In particular, most Hungarian critics argued that Madach's *Tragedy* referred to the failure of the Revolution of 1848 to produce a nation state for the Magyar people. According to this view, Madach's *Tragedy* "suggested a loss of illusions characteristic of a post-revolutionary age" and described the political despair of Hungary and of Imre Madach in the early 1850s. (See Szagedy-Maszak, "The Tragedy of Man: A Reading," 133.) *The Tragedy of Man* represented the political reality of the 1850s and the perseverance of the Hungarian people in the face of that reality. The Lord's final admonition, therefore, was meant as a kind of sanctuary for the Hungarian people and offered salvation in faith and the continuous struggle to make "Hungary" a reality. (See Lotze, *Imre Madach*, 143. See also Istvan Soter, "Imre Madach's 'The Tragedy of Man,'" *The New Hungarian Quarterly*, 5 (1965): 66. For a delineation of the Hungarian critics view of the play, see Thomas Mark, "'The Tragedy of Man': Salvation or Tragedy?" *Acta Litteraria Academiae Scientiarum Hungaricae*, 15 (1973): 291-308.) Madach's *Tragedy*, of course, can refer to the play or to Madach's personal life which most commentators on the play portray as a tragedy because of his participation in the revolution of 1848 in Hungary.

21. Szegedy-Maszak, "Life-Conception," 327.

22. Szegedy-Maszak, "A Reading," 146.

23. Szegedy-Maszak, "Life Conception," 328.

24. Thus distinguishing his work from Hegel.

25. Szegedy-Maszak describes this "polemic consciousness" in the following way: "my existence must have a purpose, I cannot see this purpose, it must have been set by something/somebody mightier than me, to learn the purpose of my existence I have to find this something/somebody." Szegedy-Maszak, "Life-conception," 329.

26. Ibid., 331.

27. Ibid., 334.

28. This quotation refers to the subtitle of Thomas R. Mark's article, "'The Tragedy of Man': Salvation or Tragedy," 291.

29. Here I am repeating the observations of Thomas R. Mark and his survey of the salvationist interpretation of the *Tragedy* and its relationship to the sociological representation of the "tragic."

30. Thomas R. Mark, "'The Tragedy of Man': Salvation or Tragedy," 307. Mark's understanding of "tragic" is largely shaped by Ludwig Wittgenstein and M. Peckam, *Beyond the Tragic Vision* (New York, 1962).

31. Ibid., 291. Mark rather sarcastically goes on to say: "It's as if the English-speaking world were to celebrate *King Lear* as asserting that God is in His heaven, and all is right with the world. And it's as if the many fine critics who have pondered *The Tragedy of Man* had forgotten what the title of the work was."

32. In his critique, Mark has noted that the salvationist interpretations of the play developed from the form of the drama, which forced the reader to confront the simple question "Is it True?" The London scene, the phalanstery scene, and the Eskimo scene were written as "future history" and <u>not</u> as a dream within a dream, as is the French Revolution scene. The reader, therefore, confronted the historical reality of the *Tragedy*.(The London scene is scene eleven. The phalanstery scene is scene twelve. The thermal death scene is scene fourteen, and the French Revolution scene is scene ten, which is a dream within the Kepler scenes, scenes eight and ten.) This has led many critics to feel that they had to answer the question of *The Tragedy of Man*. Thus, critics have read the play in salvationistic terms, ignoring the historical necessity of the London, phalanstry, and Eskimo scenes which made the drama into a tragedy. It was as if the salvationist readers came to the French Revolution scene, stopped, and skipped over to the final scene where God gave his final admonition to strive and trust, ending the tragedy with a liberating "Hungarian" state, free of the errors of nationalism exposed by Madach's *Tragedy*. Or the critics read the French Revolution, London, and Phalanstery scenes as one, ignoring their formal differences, and then skipped the Eskimo scene in order to find religious salvation, in contra-distinction to the worldly salvation of nationalism (French Revolution), capitalism (London), or socialism (phalanstery). The final words, then, were of the Lord, and that indicated the religious salvation of *The Tragedy*.

33. Mark, "Salvation or Tragedy?," 302.

34. Madach, *The Tragedy of Man*, 163.

35. Ibid., 183.

36. Ibid., 192-193.

37. The London scene is a study of the extremes of Liberty. The Phalanstery scene displays the perils of Equality, and the Eskimo scene recreates a world devoid of Fraternity. In this way, the *Tragedy* becomes "the tragedy of nature" or "the tragedy of naturalism".

38. This is basically Thomas Marks' thesis and will serve as a way to explicate science in *The Tragedy*, although we will postpone here a discussion of Mark's conception of "tragic."

39. Madach, *The Tragedy of Man*, 220-221. The reference in Lucifer's speech is to when Adam as Kepler practices astrology in order to support his research and his wife in scenes eight and ten.

40. Ibid., 233.

41. Ibid., 238.

42. According to Dieter Lotze, Madach was quite familiar with popular science materials--especially Ludwig Buchner's *Force and Matter*.

43. Madach, *The Tragedy of Man*, 245.

44. Ibid., 247-248.

45. Ibid., 251.

46. Ibid., 252.

47. Ibid., 253.

48. Ibid.

49. Ibid., 255.

50. Ibid., 264.

51. Ibid., 266.

52. Ibid., 270.

53. Ibid., 271.

54. Madach, *The Tragedy of Man*, 275.

55. Ibid., 276.

56. Ibid., 278.

57. Ibid., 278-279.

58. Ibid., 286.

59. Ibid., 287.

60. Madach, *The Tragedy of Man*, 300.

61. Leo Szilard, "Recollections," 3.

PART II
TRAGIC SCIENCE EXTENDED

CHAPTER THREE
THE POLITICAL "SCIENCE" OF LEO SZILARD

Szilard's reference to Imre Madach's *The Tragedy of Man* in his "Recollections" highlighted the a-rational, neo-romantic context of Szilard's science. The tragic situation of science in Madach's *Tragedy* made Szilard's science as represented in his "Recollections" comprehensible. The childlike nature of Szilard's science echoed Adam's youthful yearning for knowledge in the *Tragedy*, and Szilard's teleological principle, "It is not necessary to succeed in order to persevere," recalled the admonition of the Lord in Madach's *Tragedy*. His reference to Madach's work, therefore, displayed Szilard's embrace of a "tragic science" that understood itself and the world in terms that reiterated the drama of *The Tragedy of Man*. In phrases such as "addicted to Truth" and "predilection for 'Saving the World,'" Szilard engaged the scientist in a tragic struggle against the thermodynamic degeneration of the world (the Eskimo scene) and dogmatism.

Szilard's tragic science displaced the traditional categorical boundaries of science. Tragic science, as Szilard so eloquently described it in the principles of

"Recollections," encompassed epistemological truth and moral action to save the world. For Szilard the extension of "science" into political and ideological realms was both natural and inevitable, because science had a special role to play in both knowing the truth and acting on that knowledge to "save the world." This aspect of Szilard's tragic science, implied by his description of it in his "Recollections," explicitly emerged as Szilard confronted the political problems of Weimar Germany.

While reflecting on the fate of Germany in the post World War II era, Szilard recalled the Germany he had known as a student and *Privatdozent* at the University of Berlin in the 1920's. He remembered "the times of the worst inflation," the Kapp Putsch and the organized resistance to it by the "working class and the victorious allies," the "genuine progress which [the German people] made towards democracy," the depression of 1929, and the rise of "another aggressive nationalist movement."[1] He did not blame the rise of Hitler on the depression. Instead, what Szilard recalled was the "absence of any constructive attempt to cope with [the depression and unemployment]" and the "conspicuous absence of any resistance to [the nationalist movement] on the part of those who opposed it."[2] All of this convinced Szilard by the middle of 1931 that the nationalist movement would come to power eventually, and he decided to leave Germany.

In these political circumstances Szilard did something else besides simply leave Germany. In late 1929 and early 1930, at the time when he first began to believe that parliamentary government in Germany would not survive for more than "one or two generations," Szilard composed a short political proposal that was never published, entitled simply "*Der Bund*":

> In the "Society of the Friends of the Bund" those persons should come together who wish to further the creation of a closely knit group of people whose inner bond is pervaded by a religious and scientific spirit. The external frame into which such a group should grow would be the "Bund" itself.[3]

The ideology of this document, succinctly displayed in the above quotation, became a significant part of his political expression.[4] In 1930, he unsuccessfully tried to interest some of his colleagues in founding an organization patterned on the ideas in "*Der Bund*." During his years in England from 1933 to 1938 he revised and expanded his thoughts on the *Bund*, and in 1949 he commented on the origins of this political proposal in a memo he prepared for the Ford Foundation.

The significance of "*Der Bund*" has been little recognized by the commentators on Szilard's political thought. The editors to the second volume of *The Collected Works of Leo Szilard*, which contains a translation of most of the information on "*Der Bund*," listed its significance as being a representation of the "private dreams which lay

behind many of Szilard's later plans."[5] Barton Bernstein, in his "Introduction" to the third volume of *The Collected Works of Leo Szilard*, noted that this was "the first of various bold, elitist ideas" and served as "a forerunner of his many postwar projects."[6] Little other than this has been said about it other than noting Szilard's reference to the pre-World War I German youth movement in his 1949 explanation of "*Der Bund*" and noticing that Szilard's writing of "*Der Bund*" coincided with Szilard's interest and contact with H.G. Wells.[7] This explanation of "*Der Bund*" has created the impression that this proposal simply represented Szilard's version of H. G. Wells's "open conspiracy."[8]

Such a presentation has failed to account formally for Szilard's political expression. Szilard's political proposals from 1929 to (at least) 1949 incorporated the idea of the *Bund* and therein lay the significance of this political expression. To understand Szilard's political proposals, therefore, "*Der Bund*" must be de-scribed by understanding it as formally representing its own political situation, its own political reality. By examining "Der Bund" in this fashion, this chapter will display the political reality described by Szilard's proposal. First, Szilard's proposal will be outlined. Then we will exam the context of the rhetorical heritage of Szilard's *Bund* by explicating the history of the German youth movements. This context will then be used to display the political meaning

of Szilard's "tragic science."

According to Szilard, the "society" (*Gesellschaft*) described in "*Der Bund*" was to be composed of the "best" boys and girls who would become junior members of the *Bund*. Junior members would study and attend workshops together, so that they might "get acquainted with each other's thinking."[9] They would be together for several years, and then the junior members would elect from among themselves the "best" who would then become senior members of the *Bund*. After graduating from university, members would have the option of becoming loose members of the *Bund*, and going home to pursue their careers, or entering the "Order" of the *Bund*, which "imposes on its members a life of sacrifice and service."[10] Members of the "Order" would be allowed to pursue their careers, but certain sacrifices would be required, such as turning over all money except that needed for basic existence, and for some perhaps even celibacy.[11]

The "Order of the Bund" would be directed by a "governing body" of about 40 people to whom the responsibility for running the Order would be delegated by the "individual cells" out of which the "Order" was composed.[12] This body would consist of members of the *Bund* between the ages of 25 and 60 and should be evenly composed in terms of age. The members of the governing body would be delegated for life and could not be recalled. The governing

body would be replenished, however, by releasing certain members from active membership and putting them in a "reserve body." These reserve members could attend deliberations and be elected into the leadership of the "Order," but they could not vote in the governing body of the *Bund*.[13]

Three people selected from the governing body would act as the leadership of the "Order," but these three people were not to be individually elected. They would be elected as a group. In a separate ballot, a second group of three would be elected as an opposition leadership. The opposition would not have an active roll in managing the "Order," but would simply observe and control the "Order's" leadership by calling for a new election when it felt it was necessary. In addition, members of the opposition group could never become members of an "Order" leadership triumvirate later on.[14]

Szilard hoped that the "Order" would be the ultimate political expression of his *Bund*, and he believed that:

> If such a group, profoundly cohesive in spirit, were to exist, then presumably it would exercise a potent influence on the shaping of public affairs even without any particular inner structure and without any constitutionally determined rights. There are sufficient examples from the past where certain groups of people or institutions exercised a decisive influence without occupying a position specified by the constitution.[15]

This description of his *Bund*, a representation of the German political expression, captured the connotations of the German words *Gessellschaft* and *Gemeinschaft*. His *Bund* was to

be the broadest of political entities which had both political structure and political ideology but could not be reduced to either. His political organization was to be both a political structure and a political ideal, although it was neither strictly one or the other. It was not be thought of as a political party or a political platform, although it incorporated both. Perhaps it could be best described as the idealized state itself within which politics was to be played out.

Szilard reiterated a similar definition in his Ford Foundation Memo of 1949 as he attempted to define his *Bund* for an English audience. He specifically stated in that memo that it was "not supposed to be something like a political party . . . but rather it was supposed to represent the state."[16] Szilard's state was to be a future state which developed out of "the then existing political system" and could take over the functions of government "if and when the parliamentary system in Germany collapsed, one or two generations hence."[17] He designed his *Bund*, therefore, to represent the then existing system of parliamentary democracy in Weimar Germany in late 1929 and 1930 and a future state which evolved out of the political system of Weimar Germany.

In one sense then, Szilard's "*Der Bund*" should be understood as a depiction of Szilard's understanding of the Weimar Republic. In "*Der Bund*," Szilard noted the

"indispensable" nature of democracy "in the sense that what government does must not run counter to the public opinion of the broadest stratum"--explicitly aligning himself with the democratic principles of the Weimar republic. He also structurally embodied the parliamentary nature of democracy in the Weimar Era in the "ruling body" of the "Order of the Bund."[18] The team leadership style of government in the "Order" and the ever present opposition, able to call for elections at almost any time, presupposed a parliamentary style of government in which power and authority were delegated to leadership groups (not to individuals), and coalitions representing different perspectives counter balanced one another and prevented a monopoly of power. At the "cell" level as well, there was also a spirit of representation as members delegated responsibility to other members deemed worthy to serve in the "ruling body."

In reviewing parliamentary democracy in the Weimar Era in "*Der Bund*," Szilard also captured the disorder of Weimar democracy. "At this time," Szilard noted, "there exists hardly anything resembling the formation of a community purpose (*Willensbildung in der Gemeinschaft*)," and he lamented "the political parties working against one another," "the brief periods in office of the successive governments," and the "primitive" way in which community purpose was established by "the misinformed newspaper reader."[19] This disorder in the parliamentary system

resulted from the over-representation of individual interests in the democracy of the Weimar Era, according to Szilard. This problem stemmed from the long standing relationship between parliamentary democracy and the laissez faire economic system. According to Szilard, this economic system was "to a certain degree built into the parliamentary-democratic system," and for that reason, he accepted and believed in parliamentary democracy.[20]

Even in his acceptance of parliamentary democracy, however, Szilard remained ambivalent toward it. Szilard criticized the fact that parliamentary democracy implied a certain hands-off approach to the political parties that allowed them to do whatever they wanted. At the same time, Szilard wrote of an undeniable structural connection between the laissez faire economic system and the parliamentary democratic political system. In "*Der Bund*," he vaguely talked about the "life-styles" (*Lebensformen*) of civilized countries being "determined by the mechanics of those forces which appear as the moving forces behind this [laisser faire] economic system."[21]

Szilard's ambivalence toward parliamentary democracy and laissez faire economics can also clearly be seen in an unpublished section of "*Der Bund*" entitled "The Convictions of the Friends of the Bund" (*Die Gesinnung der 'Freunde des Bundes'*). Here he focused on the evil of the "egotistical impulse" in a capitalist, democratic society that

"psychologically" isolated people "so that they are forced to struggle against their fellow man."[22] At the same time, Szilard did not relegate egoism to an unimportant roll in his hypothetical society. To that point, Szilard noted that within the members of "The Friends of the Bund" there will be divergent opinions about "how important egoism still is today, and the importance one must probably admit to it in any society," but, Szilard concluded, a certain type of social egoism must be considered bad--a divisive egoism in which social entities were forced to compete with one another. He gave as an example of this social paralysis, Berlin of the post World War I era, and described how the unification of the city failed "because the representatives of Schöneberg could not decide to agree on a unification which would have thrown the Schöneberg taxes in a pot with the Charlottenberg taxes and become property uniformly of the city of Berlin."[23] "What could Schöneberg have won by that?," Szilard wondered, and he noted in the next paragraph, "With someone who acts in his own interest, one will always feel less complete than with someone of a different opinion or a group."[24]

"*Der Bund*" reflected Szilard's thoughts on egoism. The *Bund* was to provide a group in which one could feel complete. Szilard's search for completeness in the *Bund* emerged in this sense from his perception of the political discord and egoism of Weimar Germany, and he signaled this

concern by adopting a political expression that harmoniously reconciled the self with the group through the body politic. That is, he circumscribed his political concerns and his political "science" in the idea of a *Bund*.

In accomplishing this Weimarian political task, Szilard recalled the rhetoric of the German youth movements. As he said in his "Recollections":

> I drew upon the experience provided by the history of the so called youth movement, a spiritual and moral movement among the youth of Germany, which originated and culminated before the First World War. This movement had represented what was best in Germany and had a profound and on the whole beneficial effect, extending for about one generation beyond its cessation.[25]

Despite giving this credit to the youth movement, Szilard never belonged to any particular youth organization while he was in Germany in the 1920's.[26] The only particular reference that Szilard made to a youth movement organization was a vague reference to a "*Völkerbund*" in an unpublished version of "*Der Bund*."[27] This could have referred to the "*Wandervogel Völkischer Bund*" (WVVB), one of the four *Wandervogelbünde* of the late teen period. Such an interpretation would be consistent with his description of the inspiration for "*Der Bund*" coming from the pre-World War I youth movement since the WVVB descended from that period, but Szilard never claimed that a social connection to one of these groups led to his writing "*Der Bund*." Instead, he saw himself as echoing their political rhetoric and not

repeating it. He "drew on the experience provided by the history" of the early youth movement, and their history echoed in Szilard's description of "*Der Bund*".

The historical voices that Szilard referred to echoed the concerns of late nineteenth-century teenagers who demanded to be heard:

> Youth, until now only an appendage of the older generation, excluded from the public affairs of the nation and forced into a passive role of learning - into a frivolous, negative role in society - is beginning to assert itself . . . . Youth wants its capacity for pure enthusiasm about the highest tasks of humanity and its capacity for unbroken faith and belief in the noble existence to be developed into a refreshing, rejuvenating element in the spiritual life of the nation. And youth believes that our nation needs nothing more today than such a spiritual rejuvenation.[28]

The pre-World War I youth movement, known as the *Wandervogel*, reflected a romantic middle-class teenage reaction to the culture and strictures of Wilhelmian Germany.[29] It began in 1896 when Hermann Hoffmann, a student at the University of Berlin, organized group excursions for a study circle of students at the grammar school in Steglitz. At first, the students went on day long walks to the Grünewald. Later they went on longer trips over the Harz mountains. By 1899 they were going on four week trips through the Bohmerwald between Bavaria and Bohemia.[30] A national youth movement grew out of this small group of youths, which emphasized getting out of the city and wandering through the countryside. Following a 1901 meeting in Steglitz of five group leaders, the movement spread

throughout Germany. By 1911, fifteen thousand German youths participated in the movement and by 1914, there were 25,000 members in 800 local branches.[31]

There were no set rules for the various *Wandervogel* groups set up through out Germany, but they shared "a certain style in their activities," which was exemplified by the group led by Karl Fischer, one of the early influential leaders of the Wandervogel.[32] This style included (1) a simple, sometimes primitive lifestyle, (2) hiking in the woods, and (3) the encouragement of personal expression through theater, poetry, literature and music. This pre-war youth movement was particularly successful at developing music, bringing about what Walter Laqueur has called "a renaissance of German folk song."[33]

Although these activities have indicated to historians that the *Wandervogel* movement was clearly a part of the general *Kulturkritik* of late nineteenth century modern bourgeois German society, it has been difficult to categorize the political ideology of the movement.[34] The various *Wandervögel* had no explicit economic or political program. They did not adopt a socialist or right wing revolutionary political platform. The movement was a rebellion against the bourgeois culture of Wilhelmian Germany, but in the *Wandervogel* period of the youth movement, this rebellion was never transformed into a political platform.

Membership in a *Wandervogel* did not require the adoption of any sort of explicit political ideology. Its middle class members wanted to escape what they perceived to be the confining lifestyle of middle class, urban, industrial life. Instead of political reform, they sought freedom from the city, industry, and the authority of their parents, in hiking, camping and fellowship among their peers. In this new freedom they also hoped to find a new wholeness, a new completeness, to fill the gap created by what they perceived to be the fragmented life of modern bourgeois society. Thus, the *Wandervogel* emphasized cooperation, fellowship and personal expression, not political dogma or revolutionary political change. The emphasis was on individual development, and they copied the style of the wandering scholars of the middle ages. As such, membership involved not so much a political identification, as a personal developmental experience.

Because it was a romantic (or at least idealistic) *Erlebnis*, many who participated in the movement have described its importance, but the character of the *Wandervogel* experience seems to have been as varied as the number of people who participated. Hans Blüher, the first historian of the *Wandervogel* movement, found adolescent eroticism. Karl Fischer and later Gustov Wyneken found an impetus to educational reform. All felt it to be a positive spiritual experience, that profoundly, if somewhat

nebulously, affected their lives, and this generation of participants carried this experience with them into the universities after the war.

The literature on the German youth movement has mostly reflected this positive tone. Many of those who actually participated in the movement have documented and extolled the youthful virtues of the movement, in particular the early *Wandervogel* movement and its pre and post World War I ancestors encompassed in the so called *Freideutsche Jugend*.[35] Nevertheless, discussions of the *Wandervogel* and the youth movement in general have not escaped the scrupulous search for the origins of German fascism. A considerable body of literature has described the early youth movement as a precursor to the conservative reform ideology of the Nazi party and the youth fanaticism of the *Hitlerjugend*. According to this historical understanding of the youth movement, even the *Wandervogel* conditioned its members to accept more radical political movements like the Nazi's.[36]

This negative indictment of the youth movement has not been followed by all historians, however. The most recent and comprehensive scholarship has taken a more developmental approach to the youth movement, distinguishing between the *Wandervogel* period (1898-1913), the tumultuous but somewhat more politically conscious period of *Freideutsche Jugend* (1918-1923), and the even more fragmented and politically

conscious period in which the political organization of the *Bund* dominated--the so-called *Bündische* period (1924-1933). The development of the movement, according to this historiographical tradition, illustrated an idealistic neo-conservative reformist context which was contiguous but not conjugally related to Nazi fascist ideology or the *Hitlerjugend*.[37]

By 1920, the unity of the *Bünde* within the youth movement began to disintegrate as the character of each individual *Bund* overshadowed the importance of a single youthful alliance of *Bünde*, the grand political dream of the pre-World War I youth movement.[38] In 1923, a final attempt was made to revive the idealistic spirit of the movement at a final meeting at *Hohe Meissner*, a mountain to the south of Kassel. This meeting failed to unite the various groups within the youth movement and signaled the beginning of a new phase in the movement referred to by most historians as the *Bündische* youth movement.

The youth movement as a whole had always been a very diverse movement consisting of various Wandervögel groups, *Jugendpflege* organizations, *Neupfadfinder* groups (after World War I), Catholic, Protestant and Jewish youth organizations and many others. Any unity it might have had, even if we look at only the *Wandervögel* groups, was at best a tentative one, and the defeat of Germany in the war and the revolution of 1918 destroyed most of the ideological

unity that might have existed within the youth movement. As groups responded to the establishment of the Republic in various ways, more politically oriented organizations emerged. Left wing socialist and communist groups as well as right wing organizations appeared during the political turmoil and slowly became more closely associated with the political parties which most closely represented their ideological interests.[39]

In addition to political youth organizations, traditional confessional youth organizations, which had been inspired by the *Wandervogel* movement, began to assume a more independent character. The Catholic youth movement grew and consolidated throughout the 1920's. The Protestant movement exploded after the war and several Protestant organizations emerged within the youth movement. Jewish youth groups started before the war became more stridently Zionist after the war. The message of youthful empowerment in Catholic, Protestant, and Jewish youth organizations gradually submerged into religious institutions in the Weimar period just as the politically oriented groups had submerged into the political organizations.[40]

A number of groups remained at the center of the youth movement spectrum nevertheless and claimed a primary allegiance to the heritage of the *Wandervogel* and *Freideutsche Jugend* movements. These organizations, which included such *völkisch* organizations as the *Blut und Boden*,

Bund der Artamanen, and the *Wandervogel*-like umbrella organization, the *Deutsche Freischar*, emerged from the various *Alt-Wandervögel* and the *Neupfadfinder* groups in 1926. These diverse groups, described by historians as the *Bündische* youth movement, voiced the neo-conservative, youthful spirit of the Weimar era:

> The Deutsche Freischar is a group of people that wants, on the basis of its experience in the youth movement, to lead its life towards itself and the nation in unconditional personal freedom together with a strong sense of responsibility . . . . The basis of communal work is inner truthfulness, respect for other views, and readiness for mutual service.[41]

According to the historian Peter Stachura, the political expressions of these groups "represented a more serious minded, organized, disciplined, and activist phase in the evolution of the independent youth movement."[42] Each group tended to place more emphasis "on the theoretical basis of their activities."[43] This created friction between the different organizations as each group "stubbornly and vociferously maintained its own individuality and autonomy."[44] Walter Laqueur has differentiated between the *Wandervogel* and the Bündische youth by saying that "the former was more individualistic in character, whereas the latter laid more emphasis upon the collective."[45] Rudolf Kneip has spoken of an awakening ("*bündische Erwachen*") in which "the solitary person was pushed back in favor of the journey of entire groups, Gau or Bünde."[46]

Despite this gesture toward the collective, which has

led many historians to link the *Bundische* movement with the *Hitlerjugend* and the rise of the NSDAP, the leadership style and the rhetoric of the *Bündische* movement remained significantly different from that of the NSDAP. *Bund* leaders were always elected by their groups, whereas *Hitlerjugend* leaders were appointed by higher ups.[47] *Bund* youth groups were also much more diverse and less categorical in their commitment to a political ideology. The *Deutsche Freischar*, for example, did not commit itself to an active role in party politics until July 1930 when it became involved in the formation of a centrist political party, the German State Party (DSP), whose primary aim was to rise above the politics of special interests.[48] Even in the rhetoric of a *völkischer Bund* such as the *Adler und Falken*, a reluctance to join in the political fray could be found:

> National Socialism is essentially related to our fundamental outlook. We can never as a group become involved in daily politics, nor do we wish to. We none the less hope to be, in a higher sense, politically effective.[49]

This has led many historians (and not just youth movement apologists) to conclude that the NSDAP and the *Hitlerjugend* can be distinguished by the *Bundische* movement's romantic political "higher sense," which conceived of political change as individual participation in a self-fulfilling organization steeped in utopian idealism.[50] Such political dreams were elitist in nature to be sure. The masses were considered worthy of human

consideration though not necessarily of inclusion in the political process itself. The political process, however, was thought of as an intellectual exercise in utopian logic, and as such it remained outside and above the fray of daily politics. The political ideology of the *Bund* was not as wedded to the incorporation of political ideology in the power of the state as was the NSDAP. Political effectiveness for the *Bundische* movement remained in a higher realm of political idealism which mediated the problems of the modern German democratic state--economic dislocation, political divisiveness and capitalistic individuality--in the extra-political communal experience of the *Bund*. Such idealism, of course, left them both open and unprepared for the Nazi seizure of power in 1933.

Born in the idealistic historical context of the *Wandervogel* Szilard's *Bund* echoed the idealistic, neo-conservative voice of the Weimar youth movement just as the Weimar *Bünde* echoed the neo-conservative ideological elements of the pre-World War I youth movements.[51] Szilard's *Bund* reiterated the importance of community and the development of individual character associated with the primarily pre-World War I *Wandervogel* movement.[52] Like the *Wandervogel* movement, Szilard began with the understanding that within western civilization there existed a problem of "the formation of community purpose."[53] Also like the

Wandervogel movement, Szilard described a higher political, economic, and spiritual order in his *Bund*. "*Der Bund*" signified, in this sense, his attempt to regain a sense of community.

Szilard portrayed the *Bund* as the place where the evolution to a higher stage of political development could be conceived, although the exact nature of that development could not be defined at the *Bund*'s conception because Szilard's *Bund* was not to be a politically ideological organization. Instead, the social-spiritual bond, the social covenant, if you will, would guide societies evolution from a "primitive" sense of social purpose to a "progressive development of public life." Parliamentary democracy and laissez faire economic principles were not to be destroyed, but simply served as the starting point from which a higher and better system of government and economic organization would develop. In a moral and spiritual sense, therefore, the *Bund* was extra-political. It stood outside of normal political influence while at the same time evoking the highest moral political sense from its members. As such, membership in "*Der Bund*" was not a dogmatic espousal of doctrine or political activity aimed at power, nor did it subjugate individuality. Instead it was to be a personal and highly individualistic political experience (*Erlebnis*) in which individual fulfillment came in the emotional commitment one shared with others and the seemingly

boundless political possibilities of humanity within the *Bund*: "Nobody should renounce even the boldest of hopes before human nature has been given every opportunity to demonstrate its limits."[54]

This idealistic explication of Szilard's Bund has captured only part of the historical context conjured up by Szilard's historical reference to the pre-World War I German youth movements. The neo-conservative aspects of the German youth movement were also recalled in Szilard's *Bund*, reflecting a later historical context and echoing the voices of a more conservative era in the history of the German youth movement.

Szilard's *Bund* was to be an organization or society which evolved over time and eventually would become an extra-political group, "profoundly cohesive in spirit," which provided a "potent influence" on public affairs in a utopian society.[55] In this sense, Szilard's *Bund* reiterated the utopian thinking characteristic of the *Bündische* youth movement common in the Weimar period in the late twenties. "*Der Bund*" did not describe itself in terms of political ideology. Szilard specifically rejected both fascism and communism because of their lack of commitment to some sort of public forum.[56] Szilard also described a general fear of the growth of the bureaucratic state in which the power of permanent civil servants grew with no structural check that would "offer a guarantee of a well-thought-out, large scale

definition of aims."[57] He saw this happening even within the parliamentary democratic systems in existence in 1930. Szilard, therefore, designed his *Bund* to function outside of any bureaucratic state wedded to a political ideology and to remain an alternative to whatever the dominant political system may be (present or future), so that the *Bund* could provide a "Willensbildung in der Gemeinschaft."

Szilard made this ideological commitment to remain non-political explicit in the structural details of his *Bund*. For example, in choosing the "best" boys and girls to become junior members of the Bund, great care was to be taken not to allow the choices to be made by those (usually adults) who might be subject to political influence: "Schoolmasters, the Bund or the Friends of the Bund should hardly be entrusted with the choice as they might be influenced by political considerations."[58] Szilard also wanted to restrict the political involvement of junior members of the Bund:

> To keep [junior members of the Bund] open-minded as long as possible, they should not be allowed to join, even as a formality, any political party or philosophical movement [weltansschauliche Partei] before they have reached the age of 30 years. [59]

Junior members nevertheless should be informed of a wide variety of political movements, and they should be encouraged to have a keen interest in public (not to be confused with political) life. This interest in public life would lead them to challenge traditional assumptions of political ideology, but at the same time required them to

remain independent of any political ideology--including democratic parliamentary ideology.

This ideological commitment to political independence defined the political character of Szilard's *Bund* and theoretically allowed *Bund* members to rise above the political factionalism, confusion, and dislocation of the modern bureaucratic state. It also logically permitted members of Szilard's political society to develop an ideological reality outside of political ideology that could someday restructure all of modern political culture. In this sense, Szilard's *Bund* reiterated the extra-political character of the *Bund* in the *Bündische* youth movement.

The particular extra-political nature of Szilard's *Bund* depended on a "religious and scientific spirit."[60] A religious and scientific bond bound together the "best" individuals who were trained to be "independent thinkers." This "inner cohesion" allowed the *Bund* to "renew itself on its own."[61] In "The First Step" toward the founding of the *Bund*, this religious and scientific spirit also served as a guide for choosing who should belong and who should not. As Szilard explicitly stated in "*Der Bund*," "What we want are boys and girls who have the scientific mind and a religious spirit."[62]

By choosing these characteristics, Szilard described a political order dominated by a scientific elite that had a religious sense of commitment to the *Bund*. His *Bund*

described in this sense a religiously scientific order, non-dogmatic in its ideals and social configuration and religiously devoted to the ideals of science, particularly the objectivity of science. Members of the *Bund* were to strive to remain extra-political and reasonably, using their scientific minds, contest ideas. Younger members of the *Bund* were to be taught to think independently and to "do so in areas where for most people passions and emotions prevent clear thinking."[63] By reiterating these objective ideals of science in his *Bund*, Szilard joined the political nature of the *Bund* with the ideals of science and expressed his belief that a religiously scientific political order was "the only weapon" against "the confusion of ideas existing today [1930]."[64] "One has to trust", wrote Szilard, "that children who are able to think, who have been educated to independent thinking, and who seriously go about it will discern the truth from the confusion of conflicting opinions."[65]

In this youthful affirmation, Szilard's "tragic science" emerged in the political culture of the German youth movement. Szilard's ever inquisitive, youthful Adam-the childlike scientist committed to his search for truth-found political expression in the *Bund*, through which the scientist remained forever the inquisitive child. The scientist, in and through the *Bund*, could transform the tragic pursuit of truth into the tragic task of "Saving the World." Scientific knowledge and political action were

finally joined in "*Der Bund*".

Szilard's political utopia, as expressed by "*Der Bund*," was not a backward looking, nostalgic utopia. "*Der Bund*" did not offer an escape from modern society in a lifestyle of the past. Nor was it a politically ideological utopia wherein hope lay in the empowerment of the fatherland, the people, or the state. "*Der Bund*" did not demand a political commitment in this sense.[66] Instead, Szilard's political "science" called for merging politics with an ideological reality attained and maintained by science, and described scientists as a *freischwebende Intelligenz* (a socially unattached intelligentsia) that recognized the significance of science in the pursuit of spiritual, political and natural Truth. The political "science" of Szilard was, therefore, a total ideology that guided all political action and authorized scientists to distinguish between true and false, between true ideology and political illusion.[67] In this sense, Szilard's "*Der Bund*" represented a Weimarian prescription for science, politically and morally situated before the Nazi seizure of power, comfortable in its elitist sense of scientific authority, ideologically committed to an extra-political "science" and hopeful of a scientific utopia.

Notes

1. Undated personal history document, *Szilard Papers*, Box 40, Folder 7, 1.

2. Ibid.

3. Leo Szilard, "*Der Bund*" in *Leo Szilard: His Version of the Facts*, 23. Hereafter cited as "*Der Bund*". Most of what is contained in the *Szilard Papers* concerning "*Der Bund*" can be found in translation in this volume of the published papers. However there are some significant omissions in this translation. Any reference to these passages will be my translation and it will be so noted with the appropriate reference in the *Szilard Papers*. All the papers relating to "*Der Bund*" can be found in the *Szilard Papers*, Box 22, Folder 15 and Box 68, Folder 3.

4. Memorandum of January 26, 1949 in *Szilard Papers*, Box 68, Folder 3.

5. Editors comments in *Leo Szilard: His Version of the Facts*.

6. Barton Bernstein, "Introduction" in Leo Szilard, *Toward a Livable World: Leo Szilard and the Crusade for Nuclear Arms Control*, Helen S. Hawkins, G. Allen Greb, and Gertrude Weiss Szilard, eds. (Cambridge, Mass. and London: The MIT Press, 1987), xxv. Bernstein makes a similar kind of reference in his article "Leo Szilard: Giving Peace a Chance in the Nuclear Age," *Physics Today* 40(September 1987): 45; Michael Bess in his article, "Leo Szilard: Scientist, Activist, Visionary," *Bulletin of the Atomic Scientists* 41(December 1985), makes no reference to "*Der Bund*" in his explication of Szilard's political thinking.

7. *His Version of the Facts*, editors notes, 22, n. 2.

8. See H.G. Wells, *The Open Conspiracy: Blue Prints for a World Revolution* (London: V. Gollancz, 1928). It should be noted that Szilard, in a memo to the Ford Foundation in 1949, describes the relationship of his "*Der Bund*" to H.G. Wells by saying "'The Open Conspiracy' by H.G. Wells deals with the problem and, while it offers no satisfactory solution, it makes important contributions to it[the problem of where parliamentary democracy can function] in the first 12 or 20 pages of the first edition."(*Szilard Papers*, MSS 32, Box 41, Folder 11, 6,7.) This statement seems to support the conclusion that Szilard saw his understanding of the political problems of democracy as being similar to Wells, but he did not look to Wells for a solution. "*Der Bund*" was to be a solution, and it is the form of Szilard's political solution which is of interest if we are to understand his political expression.

9. Leo Szilard, "*Der Bund*," 26.

10. Ibid., 27.

11. Ibid., 27-28.

12. These cells were also to be made up of about 30 to 40 people who were familiar with one another and kept in close touch with one another. This comes from a section of "*Der Bund*" which was not translated for the second volume of Szilard's published papers. See *Szilard Papers*, MSS 32, Box 22, Folder 15, "*Der Orden des Bundes*."

13. Ibid.

14. Ibid.

15. Leo Szilard, "*Der Bund*," 25.

16. *Szilard Papers*, MSS 32, Box 41, Folder 11, 11. My emphasis.

17. *Szilard Papers*, MSS 32, Box 41, Folder 11, 8.

18. Leo Szilard, "*Der Bund*," 24.

19. "*Der Bund*," 23. See Modris Eksteins' *The Limits of Reason: The German Democratic Press and the Collapse of Weimar Democracy* (Oxford: Oxford University Press, 1975) for an analysis of the press in Weimar Germany. Eksteins points out that private ownership and large diversity made the press during this period particularly vulnerable to political influence during times of economic crisis--as in the early twenties and then again in 1929 and 1930. Financial constraints often played a role in newspapers quickly rallying to popular political sentiment and succumbing to political and economic pressure from political parties and big business, making any semblance of political independence hard to maintain.

Szilard's reference to the press here indicates his distaste for this new reality of the press in the Weimar period and the role it played in what might be called the modern politics of the masses.

20. "*Der Bund*," 23. In a paragraph from a version of "*Der Bund*" that has not been published, Szilard formulates the relationship between the social system and the laissez faire economic system this way: "The strongest form giving influence, to which man is subjected, is the type of relations he has with other men. These relations are fixed in a definite way because of the present, prevailing economic system [laissez faire]." See *Szilard Papers*, MSS 32, Box 22, Folder 15.

21. Leo Szilard, "*Der Bund*," 23.

22. *Szilard Papers*, Box 22, Folder 15. Szilard notes in this regard that he uses the "unclear and confusing" term "egotistical impulse . . . hesitantly."

23. Ibid.

24. Ibid.

25. *Szilard Papers*, "Ford Memo", Box 41, Folder 11.

26. Szilard would have been too old to actually belong to a particular youth group, but it is possible that he could have been closely associated with German colleagues who had been members of a particular Bund and who continued their activities within the student organizations at the university. Szilard, however, does not give us any personal references, and indeed it would not have been necessary for Szilard to have had close personal contacts in the youth movement for him to have been exposed to the rhetoric of the various manifestations of the youth movement. They were quite common at the time and thoroughly penetrated university life, prompting even scholarly analysis such as *Jugendbewegung and Universität* by Heidelberg's Dr. Arnold Bergsträsser and Bonn Professor Dr. Hermann Platz (Karlsruhe: G. Braun, 1927). Also, historical accounts of the youth movement had been coming out since Hans Blüher's account of the *Wandervogel* published in 1912.

27. *Szilard Papers*, Box 22, Folder 15.

28. From Peter Stachura's translation of the proclamation announcing the youth meeting at the Hohe Meissner, 1913 in *The German Youth Movement 1900-1945*, (New York: St. Martin's Press, 1981): 169. Stachura's source is "*Die Freideutche Jugendbewegung, Pädogogishesd Magazin*," no. 597 (1915): 9.

29. My discussion here owes a great deal to the work of Peter Stachura's *The German Youth Movement 1900-1945*. The introduction contains a nice survey of the monograph literature on the youth movement which includes all of the standard works.

30. Walter Z. Laqueur, *Young Germany: A History of the German Youth Movement* (New York: Basic Books Publishing Co., Inc., 1962): 15.

31. George L. Mosse, *The Crisis of German Ideology* (New York: Grosset and Dunlap, 1964): 171; Stachura, *The German Youth Movement*, 21.

32. Laqueur, *Young Germany*, 18.

33. Ibid., 17.

34. This characterization of the *Wandervogel* and its ancestors of the 1920's as a youthful manifestation of the more general *Kulturkritik* is a common one found in almost all general descriptions of the movement and cultural histories. See for example, Peter Gay's *Weimar Culture* (New York: Harper and Row, 1968): 77-79.

35. Werner Kindt's documentary history of the movement is a good example of this tradition as is the work of Rudolf Kneip. See for example Werner Kindt ed., *Grundschriften der deutschen Jugendbewegung* (Düsseldorff, 1963); Rudolf Kneip, ed. *Jugend der Weimarer Zeit: Handbuch der Jungendverbände 1919-1938* (Frankfurt, 1974).

36. Perhaps the most blatant indictment, if not the most complete, is by George L. Mosse in *The Crisis of German Ideology*. Mosse argues that the youth movement's commitment to the idea of the *Volk* was an implicit political act. He sees in their folk songs, their rambling, their *Bund* organization, and the words and deeds of the leaders of the movement, a precursor of the elitist, right wing Nazi organizations. According to Mosse, "it is erroneous to absolve the youth movement of all and every guilt for the Nazi catastrophe." George L. Mosse, *The Crisis of German Ideology* (New York: Grosset and Dunlap, 1964): 188. Some other examples of this critique of the Youth Movement are the conservative characterization of the movement in Klemens von Klemperer's *Germany's New Conservatism: Its History and Dilemma in the Twentieth Century* (Princeton, 1957) and Harry Pross's "*Vom Wandervogel zum Jungenstaat*" in *Der Zerstörung der deutschen Politik* (Frankfurt, 1959).

37. Peter D. Stachura's work, following in the footsteps of Jakob Müller makes this argument. See Peter D. Stachura, *Nazi Youth in the Weimar Republic* (Santa Barbara, Cal.: Cio Books, 1975) and *The German Youth Movement, 1900-1945: An Interpretive and Documentary History* (New York: St Martins Press, 1981); Jakob Müller, *Die Jugendbewegung als deutsche Hauptrichtung neukonsevitiver Reform* (Zürich: Europa Verlag, 1971).

38. Kneip, *Jugend der Weimarer Zeit*, 18.

39. This is easily seen in the emergence and growth of such organizations as the *Kommunistischer Jugendverband Deutschlands* on the left and the establishment of the *Jugendbund der NSDAP* in 1923. The democratic and socialist Bünde seemed to have clung to their political independence

maintaining a political orientation which aims at remaining above the normal political fray. See Stachura, *The German Youth Movement*, 94-117 for a full discussion.

40. For an account of the Catholic youth movement and its relation to the Hitler Youth see Lawrence Walker's *Hitler Youth and Catholic Youth 1933-1936* (Washington D.C.: The Catholic University of America Press)and Peter Stachura's *The German Youth Movement 1900-1945*, chapter 3. The division I have made here between religious and political youth groups is not meant to imply that there was not considerable overlap or that religious groups did not have political agendas. I am merely recognizing that religious groups and political groups began to stress their particular religious and political qualities as opposed to their connection to all other youth.

41. A definition of the *Deutsche Freischar* group from *Deutsche Freischar*, 1928, no.1, 2ff, as quoted by Peter Stachura in *The German Youth Movement,* 171.

42. Stachura, *The German Youth Movement*, 46.

43. Ibid., 45.

44. Ibid., 46.

45. Laqueur, *Young Germany*, 30.

46. Kneip, *Jugend der Weimarer Zeit*, 18.

47. Peter Stachura, *Nazi Youth in the Weimar Republic,* 94. See his chapter entitled "The Hitler Youth and the Youth Movement in the Weimar Republic" for a good general discussion of the differences between the *Bündische* movement and the *Hitlerjugend*.

48. Laqueur, *Young Germany*, 149-150.

49. Hans-Joachim Lemme, a leader in the Adler und Falken as quoted by Stachura in *The German Youth Movement*, 172, from *Der Führer*, 1929, no.4, 5.

50. This includes the work of Stachura, Laqueur, Kneip, Seidelmann, Müller and others.

51. Within this idealistic, neo-conservative political context, the echoes of the *Wandervogel* in Szilard's *Bund* resound: "It does not seem unimportant to us that the formation of a community purpose should take place in the midst of a free struggle for some sort of public opinion....To remain democratic in this sense seems almost a

permanent requirement, while we may perhaps have to regard parliamentary democracy as an outmoded form of government in the not-too-distant future. In fact it would be outmoded the moment one presumed in good conscience definitely to give up laissez-faire through the progressive development of public life." Szilard, "*Der Bund*," 24.

52. Szilard specifically cites the pre-World War I youth movement as a source of inspiration for "*Der Bund*" in his memo of 1945. See *Szilard Papers*, Box 68, Folder 3.

53. Szilard, "*Der Bund*," 23.

54. Ibid.

55. Szilard, "*Der Bund*," 25.

56. Ibid., 24.

57. Ibid.

58. Ibid., 25.

59. Ibid., 26.

60. Ibid., 23.

61. Ibid., 24.

62. Ibid., 25. Szilard never specifically stated how the selection processes would be carried out except to say that it would be some sort of self-selection process. For instance, he suggested that about three children be chosen out of a class 30 or 40. These three should at least partly be chosen on the basis of asking the entire class to vote on whom they thought were the best. Presumably, since they had grown up together, the students would know each other better than anyone else, and thus be better able to evaluate each other than any outside party using tests or interviews.

63. Ibid., 26. This commitment to scientific objectivity carried over into the social structure of Szilard's *Bund*. Younger members were to associate freely with one another and outsiders through club activities and seminars and were <u>not</u> allowed to join any political or philosophical movements. Each member was to be given the opportunity to study or work in a foreign country, insuring their objectivity on questions of nationality. For Senior members of the *Bund*, foreign work was required. Also, selection into the *Bund* was to be an objective process in which the members from a particular class would be questioned to determine who they thought were the "best" from among their peers and the

best would then be allowed membership. This selection process avoided the problems of generational bias by taking it out of the hands of the older members of the *Bund*. Szilard, "*Der Bund*," 26, 27.

64. Szilard, "*Der Bund*," 30.

65. Ibid.

66. Szilard's *Bund* cannot be clearly categorized as belonging to either the *Bündische* movement or to the *Wandervogel* movement. To reduce it to one or the other has not been my purpose. Instead, I hope that I have shown that Szilard's *Bund* is related to Weimar culture, not in the sense that it can be reduced to some intellectual category, which we describe as being Weimar culture, but because it displays some of the romantic/enlightenment features of modernity associated with the Weimar political cultural contexts in its elitist and reluctant embrace of parliamentary democracy within the political/cultural context of the possibility of a political synthesis which confronted and transcended the problems of parliamentary/capitalist society, ie. inflation, labor strikes, socio-economic displacement and stifling political factionalism. Within these context lies the possibility of an liberal extra-political reality. It is this political reality which Szilard's "*Der Bund*" represents.

My work here converges with Thomas Childers' attempts to display Weimar political contexts by focusing on the political rhetoric of Weimar Germany although it differs on the matter of intention and its scientific focus from the work of Childers. In its scientific focus it aims at a political understanding of science similar to that of Jeffrey Herf's work, but without reducing that understanding to a "reactionary" modern intellectual archetype. See Thomas Childers, "The Social Language of Politics in Germany: The Sociology of Political Discourse in the Weimar Republic," *American Historical Review*, 95(April, 1990): 331-358; Jeffrey Herf, *Reactionary Modernism: Technology, Culture, and Politics in Weimar and the Third Reich* (Cambridge: Cambridge University Press, 1984).

67. The phrase socially unattached intelligentsia is a phrase used by Alfred Weber. The idea of a total ideology is one developed by Karl Mannheim. See Dagmar Barnouw, *Weimar Intellectuals and the Threat of Modernity*, (Bloomington and Indianapolis: Indiana University, 1988), for an interesting discussion of these two in relation to Weimar Culture.

CHAPTER FOUR
LEO SZILARD'S POLITICAL SCIENCE IN A COLD NUCLEAR WORLD

During and following World War II, Szilard was an emotional leader of the Atomic Scientist's Peace Movement in the United States.[1] He was one of the first atomic scientists to push for a discussion of the future use of the atomic bomb and atomic energy in general. During the war he sparked the interest of a number of young scientists at the Metallurgical Laboratory in Chicago convincing many of them to sign a petition against using the atomic bomb, and after the war he became a spiritual founder and active participant in the Pugwash Conferences for Science and World Affairs which began in 1957. Later, in the early 1960's, just before his death in 1964, he also fathered the "Angels Project," a scientists exchange program between the United States and the Soviet Union, and a political lobby called "The Council for a Livable World."[2]

By the standards of nuclear strategists and political scientists, Szilard's recommendations on the questions of nuclear disarmament, the cold war and politics in general were aphoristic examinations of military hardware and political forces. He mostly expressed himself in maxim form with maximum effect, resulting in, as Barton Bernstein has described it, "an amalgam of the prescient, the hopeful, the

pessimistic, and the overly rational."[3] Only a few random samples of Szilard's work are necessary to verify Bernstein's assessment. Szilard's prescience can be seen in this remarkable statement of 1962:

> It is a foregone conclusion that American efforts toward creating an orderly and livable world will be frustrated in Southeast Asia and Africa because of our failure to devise forms of democracy which would be viable in these regions of the world.[4]

In 1955, Szilard displayed his hopeful political voice in this exhortation:

> It will take political and social inventions to evolve an organized world community that may remain indefinitely at peace. But real progress could, I believe, come rather fast if it were possible to gather from among the several nations involved- men who would work as a team and, being free from governmental responsibilities, could experiment with ideas and explore the feasibility of various approaches without in any way committing their governments.[5]

Underneath this optimism, however, lay a persistent pessimism as can be seen in this statement in 1960:

> At this point, I am not at all certain that this [atomic disarmament] is, or that it ever really was, a promising approach to the problem [of avoiding nuclear war]....I believe that the time has come to face up to this situation and to ask in all seriousness whether the world could learn to live for a while with the bomb.[6]

Overlaying these political mood swings the overly rational Szilard can also be found. For example, in 1961, confronting the problem of access to free Berlin, Szilard advised the construction of an elevated highway, and notes:

> As long as the two free cities [East and West Berlin] remain in existence, East Germany shall yield sovereignty on these highways to the

> corresponding free city, but East Germany shall retain sovereignty in the underpasses and in the air above the highways.[7]

The maxim character of Szilard's political commentary, illustrated by the above random citations, has made it difficult to categorize. In his day, Szilard's amalgam of political speculations were mostly ignored by his contemporaries on the extreme left and right because his political expressions lacked the systematic rigor of a political ideology. For scientists and many moderate liberals, however, Szilard was an energetic oracle, admired as much for his seemingly universal genius, eccentricity, and inspirational character as for his systematic exposition of disarmament theories.[8]

This same sort of admiration has largely carried over into historical representations of Szilard's political thinking, where Szilard often has been eulogized as his political views were described as inspiring and clever, but unsystematic attempts to deal with the political realities of his times. According to these historians, Szilard was a deliberately unconnected political experimentalist, who "often willed not to understand American politics."[9] Presented in such a fashion, Szilard has been categorized as unrecognizable within the context of post-war political thought in United States.[10] This eccentric view, however, has ignored the opportunity which "Szilard" presented for exposing the mythical significance of Szilard's political

science in post-war political culture. Here, we will explore Szilard's political commentary with its mythical significance in mind, beginning with his opposition to dropping the atomic bomb on Japan and his views on ensuing events.

In a 1945 petition to the President, Szilard emphatically stated his opposition to using the atomic bomb:

> The development of atomic power will provide the nations with new means of destruction. The atomic bombs at our disposal represent only the first step in this direction, and there is almost no limit to the destructive power which will become available in the course of their future development. Thus a nation which sets the precedent of using these newly liberated forces of nature for purposes of destruction may have to bear the responsibility of opening the door to an era of devastation on an unimaginable scale.[11]

Many years later, in an interview by *U. S. News and World Report* in 1960, Szilard repeated clearly and forlornly that "I opposed it [the dropping of the bomb] with all my power, but I'm afraid not as effectively as I should have wished.[12] Such statements accurately portrayed Szilard's attempts to obstruct the use of his nuclear progeny, the atom bomb. Even before the atomic bomb was dropped, Szilard had already set out to "save the world" from the devastation of nuclear war. He wrote a memorandum on the implications of atomic weapons and atomic energy that he planned to deliver personally to President Roosevelt. Szilard recognized in his memo, written in March of 1945, that using the bomb against Japan appeared

likely, but should not be undertaken because of the nightmarish nuclear possibilities it might unleash in an already precarious political situation. Through this memo and in personal conversations, Szilard hoped to persuade Roosevelt not to use the bomb. Roosevelt died, however, before Szilard could arrange a meeting.

Szilard then tried to see President Truman. Truman would not see him but arranged for Szilard to meet with one of his advisors, future Secretary of State James Byrnes, who gave Szilard his polite but cool attention at Byrnes' home in South Carolina. Szilard's memo, therefore, never received the personal attention of a president as he had hoped it would, and it did not become public until it was published in the *Bulletin of the Atomic Scientists* in 1947.[13]

Szilard was not finished however. Later in 1945, he attempted to influence the scientific panel of the "Interim Committee" on the atomic bomb program set up by Secretary of War Stimson to evaluate, among other things, the role of the bomb in the postwar period. He met with Robert Oppenheimer, a member of the committee, and tried to persuade him that the bomb should not be used. At that time, Oppenheimer did not share Szilard's concerns over the military use of the bomb and its political repercussions, and their discussion was quite disagreeable. As a result, the "Interim Committee" largely ignored Szilard's concerns and recommended using the bomb.

Unable to affect policy from the top, Szilard then started a grass roots petition drive among the scientists at the Metallurgical Laboratory in Chicago and enlisted the lukewarm support of Edward Teller to spread the news of the petition drive to Los Alamos. Szilard managed to gain support for the petition at the Metallurgical Laboratory, but, at Los Alamos, where the petition was opposed by Oppenheimer, in the last days before the successful "Trinity' explosion of the atomic bomb, his petition was overcome by events.[14] On August 6, 1945, a single atomic bomb exploded over Hiroshima. Szilard's nightmare had become a reality.

Szilard had been imaginatively familiar with the destructive powers of atomic bomb as early as 1932 because of H. G. Wells. Wells's science fiction novel, *The World Set Free*, described a world war of massive destruction caused by the use of atomic weapons. As Szilard worked on the bomb during World War II, the destructive fantasies of Wells seemed to move within the realm of possibility, and Hiroshima and Nagasaki made Wells's fantasy a reality. The devastation of these bombs confirmed in Szilard's opinion the urgency of establishing a clear understanding of the problems posed by nuclear weapons. From 1945 until his death in 1964, he grappled with the philosophical and political questions accompanying the reality of nuclear power in the world. This new nuclear world was his obsession, and, as his

political science emerged in a nuclear world, Szilard carried forth his views on politics with the fervor of an evangelist, lobbying Washington, writing articles, doing interviews, and debating scientists and politicians about questions of nuclear and foreign policy.

The most significant element in Szilard's comprehension of politics in a nuclear world was an informed understanding of the destructive power of the atom bomb, and he clearly stated the anxiety that this vision gave him:

> Can we visualize what kind of life we shall be leading when we shall have to fear for our lives and the lives of our children, when the city in which we live, as well as all the other cities in the United States shall appear to be in danger of being burned and smashed without warning?[15]

Szilard's scientific perspective gave him a special insight into the power of atom bombs and their relationship to future wars. As one of the "fathers" of the atom bomb, Szilard knew its destructive capabilities as well as those of its nuclear progeny, the hydrogen bomb. He freely discussed the destructive capabilities of the hydrogen bomb in the early fifties. At a roundtable discussion in April of 1950 he commented, "If H-bombs are exploded in some number . . . . It may well be that the number of H-bombs will be so large that this will make life impossible."[16] Such an understanding of the destruction which might be caused by the use of atomic or hydrogen bombs formed the basis for all of Szilard's political perceptions and allowed him to express the informed anxiety of the physicists who had

worked on the bomb. In his first major article in the *Bulletin of the Atomic Scientists*, "Calling For a Crusade," Szilard starkly described this anxiety:

> When we think of a war that may come perhaps ten or fifteen years from now, we do not think in terms of Nagasaki bombs....Ten or fifteen years from now giant bombs which disperse radioactive substances in the air may be set off....The traditional aim of foreign policy is to prolong peace, i.e., to lengthen the interval between two wars. We physicists find it difficult to get enthusiastic about such an objective.[17]

Along with this prescience of the destructive power of nuclear weapons, Szilard used his scientific insights to describe future political scenarios that included future scientific developments. For instance, he noted in his memo to Roosevelt that "great progress in the development of rockets" could give the enemies of the United States the ability to bomb U.S. cities from large distances.[18] Szilard also envisioned a nuclear arms race and eventually a nuclear stalemate. In his memorandum to Roosevelt, Szilard was sure that as soon as the war was over Russia would develop its own bomb. Competition between the United States and the Soviet Union would undoubtedly begin and there would be "a rapid accumulation of vast quantities of atomic bombs in both countries."[19] In his "Crusade" article written in 1947, he noted that the arms race had already begun because of the "peculiar" relationship between the United States and the Soviet Union that made it inevitable that each government, thinking that they might have to fight the other, will

pursue an arms buildup policy to insure that they will be in a position to win such a war if it comes. This was what Szilard described as the "vicious circle" of the arms race.[20]

This arms race would eventually lead to a nuclear stalemate according to Szilard, and he noted the possibility of an atomic stalemate as early as 1949 in an article in the *New Republic* entitled "America, Russia and the Bomb." In this article, published just after the Russians had exploded their first atomic bomb, Szilard was confident that Russia would develop a significant number of bombs.[21] By October of 1955, Szilard believed that the point of nuclear stalemate was rapidly approaching. Thereafter, he began to examine the concept of mutual assured destruction (MAD) and characterized nuclear stalemate as a situation in which "neither side could knock out, by surprise attack, the capacity of the other to retaliate."[22]

Szilard's comprehension of a nuclear stalemate also recalled a particular historical context. In an article written in 1949 entitled "Shall We Face the Facts," Szilard compared the conflict between the United States and Russia to the war between Athens and Sparta in ancient Greece. He viewed Thucydides' *History of the Peloponnesian War* as both frightening and sobering in its lessons for the present world situation dominated by two superpowers and noted the similarity between the arms build up of the two powers of

ancient Greece and the modern superpowers. He perceived that in both historical circumstances each power presumed that war with the other was inevitable and thus felt compelled to prepare for war.

The ultimate destruction of the Peloponnesian War illustrated for Szilard the necessity of overcoming the political stalemate. Stalemate meant eventual and inevitable war, therefore, "A solution, if there is one, must of necessity, lie outside of the pattern that governed the actions of Sparta and Athens."[23] In the political terms of the post war period, this meant that containment would only lead to war and a solution outside of this normal political pattern had to be sought:

> Whether this policy [containment] was "right" or "wrong" is not our topic here. But who can doubt today [Oct. 1949] that it is totally inadequate to cope with the problems which now confront us . . . . Somehow we shall have to find a path from containment to "contentment."[24]

To find political serenity, Szilard's political science described hypothetical solutions outside of normal cold war discourse. In his memorandum of March 1945 he did not have any clear solution in mind but indicated that some sort of "system of controls" for the raw materials of atomic energy were needed if future wars with atomic bombs were to be avoided. In his "Crusade" article of 1947, he began to describe solutions to the problems of the nuclear world within the extra-political reality of international agencies

that he hoped would avert his nuclear nightmare. Szilard reasoned that a permanent world peace must be enforced by a world government. What he had in mind was quite different from the United Nations, however. His world government had "practically unlimited authority" within the limited scope of world security and "the settlement of conflicts between nations."[25]

Although he thought that such a government was a "logical" step toward world peace, he doubted that permanent world peace could be achieved by merely addressing the idea of security. The problem of the conflict between the United States and the Soviet Union could not be solved unless there was a "general disarmament" and "control of atomic energy." As Szilard saw it, any organization set up to control atomic energy would necessarily go awry because of the military context in which the superpowers viewed atomic energy and the disproportionate power of the superpowers which made their participation in any agreement strictly "voluntary." Seeking a discourse outside these realities of the nuclear world situation, Szilard defined the problem in terms of "the question of incentives." The superpowers had to be offered incentives to overcome their paranoia and the only type of organization capable of offering political incentives which might overcome cold war paranoia was an "organized world community."

Szilard also suggested that particular agencies needed

to be created as a prelude to the formation of a world government. Each agency would have its own charter that outlined its function, and Szilard hoped that the laws of these charters would eventually become "world laws" as soon as the United States and the Soviet Union ratified them, although he conceded that "the United States, England, and Russia, cannot be expected to delegate in the foreseeable future vast law-making powers to any international body."[26] The functions of the various agencies included moving two to four billion dollars worth of United States farm products to "densely populated industrial countries" unsuited for agriculture and enforcing peace with an armed force strong enough to over come any country except the United States and the Soviet Union.[27] Szilard figured that all of the international agencies could operate on a budget of about twenty billion dollars a year.

Szilard recognized that the success of these extra-political entities depended on more than creating legal charters for a world government and its agencies. An extra-political international political spirit had to be developed as well in order to transform national loyalties into world loyalty. This political transformation would be brought about through international agencies as well. To that end, Szilard suggested the creation of an agency to control "student migration." This agency would have the authority to place as many as twenty percent of the college students in

one country in another country. These students would then be given the option of staying in their adopted country. Szilard argued that this would break down entrenched national loyalties--at least in a small, highly intelligent group. He even suggested that the agency offer to pay student expenses, especially for American students, because they needed a special incentive to induce them to study abroad. Szilard noted that: "Many American students might be induced to study under this scheme abroad where they can study free rather than at home where no one takes care of their living expenses and tuition."[28]

Szilard also described an "information" agency that would insure world access to information. It would assume control of one page of every newspaper in the world. Acting as editor of that one page, the agency would either edit the page, or assign the page of one newspaper to another newspaper; "A page in the *New York Times* might be assigned to *Pravda*, and a page in *Pravda* to the *New York Times*. It is difficult to forecast at the present time who would oppose such a scheme more vigorously, the 'publisher' of Pravda or the publisher of the *New York Times*"[29]

Proceeding from the extra-political reality of these various international agencies, in an article entitled "Can We Have International Control of Atomic Energy?" (1950), Szilard shifted his attention to the confrontation between the United States and the Soviet Union and attacked the

policy of containment. Szilard argued that a choice had to be made between pursuing containment and an agreement on atomic weapons with Russia. Containment and atomic disarmament were incompatible because the continual arming of Western Europe gave Russia "valid reasons for refusing to enter into any agreement that provides for international inspection."[30] In Szilard's view, Russia could not permit inspection and remain certain of its security. There was, as a result, no incentive for Russia to move forward with an agreement. Szilard, nevertheless, argued that the United States and Russia should choose to move toward atomic disarmament, and he outlined a possible agreement as a suggestion to stimulate discussion.

His approach was to "balance the agreement, a major point in favor of Russia against a major point in favor of America," focusing on the interests of both countries in Western Europe.[31] Under his agreement both countries would consent to the following: (1) "a completely demilitarized but united Germany," (2) a neutral block of counties consisting of France, Belgium, and Holland, (3) "a continental customs union in Europe," (4) the elimination of atomic bombs from national armaments, (5) general disarmament, and (6) sufficient inspection to insure disarmament.[32] This European strategy for an agreement, according to Szilard, took away all Russian paranoia concerning Western Europe. Russia would be militarily

dominant in Europe, but the United States gained a united Germany economically integrated into Western Europe, a guarantee of non-intervention in neutral countries, and a capitalistic economy in Western Europe.

This proposal displayed Szilard's extra-political understanding of Russia. He did not accept the idea that Russia's communist doctrines would cause it to invade Europe and argued that all of Russia's actions up to that time could be explained by its interest in security. He conceded that those who did not believe this would not accept his argument, but he insisted that those who believed that Russia was driven by its communist ideology accept the conclusion that atomic disarmament was impossible. As he put it: "They are entitled to their opinion, but they ought to draw the logical conclusion from it that there is nothing left for America to do now but to step up the atomic arms race."[33] Szilard's extra-political science never accepted this. Political containment could never yield political contentment. New extra-political means had to be found to achieve security because:

> Security based on military strength is not the only way to achieve security, nor does military strength necessarily provide security. And as time goes on and distances shrink, fewer and fewer nations will be able to attain security based on military strength.[34]

In 1955, Szilard expanded his extra-political science to include the political realities of nuclear stalemate and

explored the boundaries of the political discourse described by "MAD"--mutual assured destruction. Szilard first pondered the idea of MAD in the 1955 article "Disarmament and the Problem of Peace" and suggested that the United States and the Soviet Union adopt rules of conduct appropriate for the nuclear stalemate situation. His key rule of political engagement involved the strategy of "rationed demolition." According to this policy, each country would issue a price tag list for areas of the world which they considered to be vital:

> We shall simply list all such areas, with a price tag attached to each one, and we shall specify that if Area No. 1, for instance, is invaded we shall demolish five medium-sized cities of the "enemy." If the "enemy" permits us to do this unopposed we shall name in advance the five cities to be destroyed and give each city one week's notice in order to permit their orderly evacuation . . . . The rule of conduct here implied reads: 'Tolerate destruction of one of your cities for each city you destroy' . . . .[35]

This rule of conduct would hopefully insure that the superpowers did not engage in a nuclear conflagration over some local conflict.

These MAD considerations signaled Szilard's re-evaluation of the idea of disarmament. By 1960 he was ready to give up on total nuclear disarmament, but his political science, still informed by visions of nuclear destruction, strove to create an extra-political discourse within the political world of nuclear bombs. Since Szilard could not get rid of the bomb in order to avoid nuclear war,

he tried to reconcile his political science with nuclear weapons in an article entitled "How to Live with the Bomb and Survive-" (February 1960.) In the opening paragraphs of this paper he bluntly capitulated:

> At this point, I am not at all certain that this [atomic disarmament] is, or that it ever really was, a promising approach to the problem [of avoiding nuclear war]....I believe that the time has come to face up to this situation and to ask in all seriousness whether the world could learn to live for a while with the bomb.

He then reluctantly embraced the inevitability of MAD and offered his old suggestion as to how to avoid total conflagration, reiterating the 1955 idea of a list of price tags for certain areas in the world. Instead of offering any other solutions, however, he displayed the acumen of his political science as he described the political discourse of a MAD world:

> Occasionally there are hints in speeches of officials, who should know better, that there is work in progress on a defense system aimed at destroying long-range rockets in flight. Such a defense system is not in fact in sight. What may be in sight is a novel type of future arms race. One nation, say, America, may acquire means which would permit her to destroy in flight a small fraction of incoming long-range rockets and the fraction of rockets which she could destroy might gradually increase over the years. Russia may then respond by correspondingly increasing the number of rockets ready to be launched. Only a small fraction of these rockets would need to carry a hydrogen bomb, the rest could carry dummies.
>
> Such an arms race would be futile, with the capabilities of the offense always keeping ahead of the capability of the defense, and yet it could become a major economic burden.[36]

In October of 1961, Szilard aimed the insights of his

political science at its source, Germany, and suggested that both East and West Germany be recognized as sovereign states. According to Szilard, if they wished to form some sort of federation, they should be allowed to do so as long as their military organizations do not merge. As for Berlin, in order to avoid conflict, Szilard advised the two cities to build an elevated highway to Poland and West Germany.[37] Szilard's political science had led him once again to discourse on an extra-political reality.

In his final political commentaries in early 1964, just months before his death on May 30, Szilard put forth his final alternative to MAD, and argued for the concept of "minimal deterrent" instead of saturation parity. He viewed saturation parity, when the United States no longer had a strategic advantage and a kind of nuclear equality exists between the two countries, as a "threat to the survival of our society."[38] He argued instead for a stopgap measure to prevent total world destruction, where each side kept only the minimum amount of nuclear weapons necessary to deter aggression. This minimal deterrent concept was designed to limit the extent of the damage of a future nuclear confrontation and stop the arms race.

Even in this final commentary, Szilard still maintained that nuclear disarmament was the only real solution, leaving his political science outside of the political discourse of his day. Szilard, surrounded by the political discourse of

the cold war, argued that a disarmament agreement could still be reached although the prospects for an agreement seemed dimmer every year:

> Unless it becomes somehow possible to arrange for greatly improved communication between the administration and the Soviet government, on the one hand, and between the administration and Congress, on the other hand, no decisive progress toward a meaningful agreement on arms control is going to be made.[39]

The pessimism of his final public commentaries displayed Szilard's profound anxiety over the Cuban Missile Crisis. After this confrontation he argued that it was no longer possible to predict how far escalation might go if a nuclear confrontation came about. Supposedly during the crisis he told a group of friends that the situation was hopeless and that he hoped that "the young people would be able to pick up the broken pieces. He was too old."[40] Szilard also feared that disputes in an obscure part of the world might lead to a nuclear conflagration. He stated in his last article that Russia would not be likely to back down if another situation similar to the Cuban crises were to arise again and he warned: "America risked war in the Cuban crisis and on this particular occasion Russia yielded. It would be unreasonable to expect that in the years to come Russia will yield always."[41] The acumen of his political science left him in this political nightmare.

The nightmare of Szilard's political science marked

Szilard's extra-political discourse and separated his political vision from the cold war rhetoric of the late fifties and early sixties. His was a vision seemingly out of context, ignoring the reality of ideological differences between the superpowers, which he believed doomed the world to disaster, and portraying a rational political world devoid of ideology in which he put all his hopes for a peaceful future world. But the latter was not mere fancy, not simply overzealous optimism in rationality. It emerged quite naturally from Szilard's comprehension of the nuclear world though the lens of a political science that always already prescribed the extra-political reality of science.

Szilard's participation in the Pugwash Conferences on Science and World Affairs illustrated his perception of the extra-political role of science and scientists in a cold war world armed with nuclear weapons. Szilard was a spiritual leader of these conferences which were initiated by Bertrand Russell and Albert Einstein in 1957. The Pugwash movement, named after the location of its first conference in Pugwash, Nova Scotia, brought together scientists from the United States and Russia to address problems related to science and politics.

In a 1957 letter to Bertrand Russell, Szilard described the importance of these meetings as follows:

> I believe that it has become now rather urgent to address ourselves to the real problem which faces us, namely, "How to live with the bomb." I have in the past year given considerable thought to this

> subject and I believe that scientists could make a very important contribution to it by giving a dispassionate analysis of what needs to be done to have *stability* in the atomic stalemate.[42]

This statement clearly displayed Szilard's belief that scientists could come together and discuss the political issues of a nuclear cold war "dispassionately." Governments, Szilard continued, could not be expected "to follow moral rules. But if we are clear ourselves in our minds as to what needs to be done . . . then we could at least try to make statesmen see the light also." Enlightenment was up to and only possible for the scientists and science. Science and scientists were extra-political, and therein lay the hope and promise of the Pugwash movement.

He continued this theme in a draft of a letter explaining the opening meeting of the Pugwash movement in the *Bulletin of the Atomic Scientists*:

> Neither Americans or Russians are free to say what they think even in a closed international meeting where every remark is supposed to be off the record. But such limitations as still exist in this respect no longer represent a serious limitation in an international conference among scientists devoted to the discussion of the highly controversial issues which arise from the threat that the bomb presents to the world.[43]

Here too Szilard reiterated his belief in the extra-political nature of scientists. In fact, Szilard was so concerned and convinced of this extra-political role for science in the debate over nuclear policy that he did not sign the conference statement from the first Pugwash conference. He explained in a letter to the *Bulletin of the*

Atomic Scientists that he thought the conference's statement calling for a halt to bomb testing was "more misleading than enlightening" and noted that "It is customary for statesman to issue misleading statements . . . . I feel rather strongly that scientists should not emulate statesmen in this respect."[44] Science, in other words, had to maintain its extra-political nature, otherwise it deteriorated into politics.

Szilard's unhappiness with the political context of the Pugwash conferences led him to call for a reorganization of the conferences into smaller, more issue oriented meetings where "Discussions among scientists, who by tradition try to free their thinking from the shackles of precedent, could, I believe, contribute much to clarification of thinking in this particular area [peace in a nuclear world]."[45] Scientists, according to Szilard, were capable of this clarity because a discussion among scientists aims at discovering the truth; "If a scientist says something in such a discussion, we need not ask ourselves for what purpose he says it; all we must ask is, Is it true what he says?"[46]

Szilard then outlined how a meeting would take place. There would be approximately twenty scientists and twenty observers. The scientists would have no governmental responsibilities or connections and would examine "all aspects of the problem with the same freedom and in the same

spirit of experimentation as they are accustomed to examine specific scientific problems."[47] The observers would be those connected to the government. The free wheeling thinkers would then "catalyze fresh thinking" on the topic of discussion, and the observers would transmit these insights to their governments and to the public. Here, the intellectual hierarchy is clear. The scientists were the extra-political enlightened commentators.

In a letter to the editor of *The Times* of London, Szilard stated the same thing in a slightly different way: "Since no other groups exist which can indulge in stating such [political] truths with quite the same degree of impunity, perhaps there now devolves upon us scientists the duty of playing, in this respect, the role of the ancient prophets."[48] Lord Halsbury, a prominent English scientist, criticized Szilard on this in another letter to the editor of *The London Times* a few days later, calling Szilard's perception of the role of scientists "foolish conceit." Szilard responded at the second Pugwash conference in Lac Beauport:

> I merely stated that, these days, scientists may have a special obligation to state unpleasant political truths; I did not profess a belief that scientists have a special competence to express an opinion on the political issues created by the bomb. However, since Lord Halsbury says that to hold such a belief is "foolish conceit," I now feel bound to say that - for the reasons indicated above - I do, indeed hold this belief.[49]

With this belief clearly in mind, Szilard continued to

pursue contacts with Soviet scientists in the hope that the extra-political dialogue between American and Soviet scientists could bring about peace. In October of 1962, in a letter to Khrushchev, Szilard delineated what he would later call the "Angels Project." In that letter he proposed a series of meetings between American and Soviet "angels." He described these people as men who were "on the side of the angels" because they were "keenly aware of the need of avoiding an all-out arms race."[50] The angels were not exclusively scientists. Some held low level positions in the White House or State Department, but they all were willing to discuss--not negotiate--a disarmament agreement and to persuade governmental leaders to accept any agreement that had been worked out. Convinced that the normal political dialogue was broken down, all the angels were "groping in the dark" for a way to bring about arms reduction, according to Szilard.[51] They all felt that an extra-political dialogue was necessary, and Szilard argued that the "Angels Project" was a way to have just such an extra-political discussion.

Despite Szilard's attempts to organize an "angels" meeting in 1963, a gathering of angels never took place. William Foster, head of the Arms Control and Disarmament Agency, prohibited members of his agency or even advisors to the agency from participating in the meetings.[52] Given these political circumstances, the Soviets decided that another meeting between Soviet and American scientists was

unnecessary:

> It seems to us that the meeting between the American and Soviet scientists suggested by you could take place during the regular Pugwash conference which is planned to meet in Dubrovnik (Yugoslavia) in September of this year [1963].[53]

With that statement, the project died.

Along with the "Angels Project," Szilard had other ideas about how to stop what seemed to him to be inevitable nuclear war:

> War seems indeed to be inevitable, unless it is possible somehow to alter the pattern of behavior which America and Russia are exhibiting at present . . . It is conceivable that if a dedicated minority were to take effective political action, they could bring about the change in attitude that is needed. But such a minority can take effective action only if it is possible to formulate a set of political objectives on which it may unite.[54]

Following this line of thinking, in 1962, Szilard made a series of speeches on college campuses in which he advocated a political movement focused on the issue of nuclear war.[55] In these speeches, Szilard called for a movement founded on the belief that it was possible to get beyond the cold war "black and white picture of the world," which divided the nations of the world into two classes, "the peace loving nations, and those who are not peace loving." According to Szilard, the silent minority, which recognized the unreasonableness of present political discussions and acknowledged the legitimate concerns of the United States and the Soviet Union, needed to step forward, attempt to go

beyond political ideology and patriotism, and try to see the truth without political bias:

> The people who have sufficient passion for the truth to give the truth a chance to prevail, if it runs counter to their bias, are in a minority. How important is this minority? It is difficult to say at this point, for, at the present time, their influence on governmental decisions is not perceptible.[56]

Through Szilard's movement, this minority would make its presence felt. The movement, which came to be known under the name of The Council for a Livable World, would guide American politics toward a more reasonable policy on war and nuclear disarmament.[57]

Szilard specifically used the term "movement" and not "organization" to describe what he had in mind because he did not conceive of the council as a political organization in the traditional sense.[58] It had organization, but it was to be an extra-political organization that guided political action through knowledge and wisdom and not by prescribing a political ideology for membership. Membership involved acceptance of an attitude and not adherence to an ideology: "Those that regularly receive the communication of the council would be regarded as members of the movement, if they are willing *actively* to support *at least one* of the several specific objectives proclaimed by the council."[59] The general principles of the movement included the following: (1) the president should issue an executive order against fighting "meaningless battles in the cold war," (2)

the United States should unilaterally proclaim that it will not strike first in any nuclear war, (3) all American atomic weapons in Europe should remain in the hands of the United States and should never be placed in the hands of NATO, (4) non-governmental initiatives should be taken by the United States and Russia to discuss disarmament, and (5) private groups should be formed to discuss the political problems of the underdeveloped countries. Each member of the movement, who accepted at least one of these principles, would pledge two per cent of their annual income to the movement and would always vote in primaries and general elections "disregarding domestic issues" and "solely on the issue of war and peace."[60] For Szilard, this described the movement.

As for the organization of the movement, he had much more to say. At the grass roots level there should be local groups called "Friends of the Council for Abolishing War" in major centers throughout the country.[61] The council would set up these groups and then leave them to run on their on. Members of the movement in that area would join one of these groups. At the national level, there would be a lobbying group headed by the Board of Directors of the Lobby that would bring scientists and scholars to Washington to testify on issues before Congress and coordinate campaign contributions made to various candidates who supported the general aims of the movement.[62] There would also be a Panel of Political Advisers and a Board of Directors of the

Council. The latter would direct the day to day operations of the council.

According to Szilard, scientists would oversee all aspects of the organization:

> I would ask about fifteen scientists to serve as fellows of a council which might be called Council for Abolishing War or perhaps Council for a Livable World. The fellows (who are all scientists) would elect the board of directors, but membership on the board would not be restricted to scientists.[63]

In addition to electing the board of directors, the fellows of the council would choose the Panel of Political Advisers and the Board of Directors of the Lobby. These scientists, however, would not be involved in the actual operations of the organization, but they were to assume the "moral responsibility" for it: "In our case the moral responsibility lies ultimately with the Fellows . . . they assume the responsibility to see to it that what needs to get done gets done."[64] The fellows of the council came from a "larger group of distinguished scientists whom I shall refer to as the Associates. The Associates would all be members of the overall committee to which I shall refer as the Committee for a Livable World."[65] This committee did not have any particular jurisdiction, but it would stand ready to advise and assist the council when necessary.

Clearly, the central authority that Szilard outlined in the organizational details of The Council for a Livable World echoed the political science of "*Der Bund*":

> In the "Society of the Friends of the Bund" those persons should come together who wish to further the creation of a closely knit group of people whose inner bond is pervaded by a religious and scientific spirit. The external frame into which such a group should grow would be the "Bund" itself.[66]

Szilard's youthful extra-political science, first articulated in *"Der Bund,"* had now emerged in the contexts of American liberal politics. In this political situation, it represented a particular liberal expression of science, a scientific liberalism, if you will, which comprehended political reality in terms of an extra-political science that proclaimed to be both liberated from and liberator of political reality. As such, Szilard's political speculations on the cold nuclear world, which refused to recognize the political realities of the Cold War, described a particular position in the American political landscape that offered respite in the reasonableness and certainty of an extra-political scientific reality.

Szilard's extra-political commentary proclaimed a privileged place for those who are of "a scientific mind and a religious spirit." It was no surprise, therefore, that Szilard worked most closely with scientists and argued his political views almost exclusively with other scientists, disdaining for the most part long involved discussions with nuclear strategists and political scientists. In addition, he portrayed scientists as the great hope for "Saving the World" from nuclear destruction and overcoming the paranoia

of the superpowers. In this context, the transcendental nature of Szilard's "Angels Project" took on extra-political significance as did his active participation in the Pugwash Conferences.

Szilard's political solutions to the cold war and the nuclear arms race existed necessarily outside of political frameworks. Neither the political system of the Soviet Union or that of the United States offered a proper political solution for Szilard because to accept either system as correct implied the illegitimacy of the other and doomed the world to a nuclear arms escalation and nuclear confrontation. Furthermore, it did no good to examine the political structures of each society or try to come up with solutions to problems of disarmament within the given political systems, because to do so, one had to adopt one or the other, and the only result of that would be conflict. What was called for, according to Szilard, was an extra-political solution that transcended the existing political systems and re-established a sense of community. This extra-political organization was, for Szilard, a world government that overcame the political and nationalistic paranoia of the superpowers. He outlined this type of organization throughout the late 1940s and 1950s. In the 1960s, he proselytized on college campuses in hopes of a small realization of this extra-political experience. The result was a movement called the Council for a Livable World.

Some have called this only a small political success and described the politics of Leo Szilard as insignificant in the context of American post-war politics, but to do so misses the significance of an extra-political "science" in the Cold War era. This liberal mythos, represented by the political science of Leo Szilard, emerged from ashes of Hiroshima and Nagasaki and mingled with a political dialogue entangled in a web of nuclear hopes and nightmares, and in that context, Szilard offered peace.

Such an unlikely goal may have seemed then and may seem now an unlikely vision, but this utilitarian comprehension of Szilard's political science loses the tragic significance of the political vision of Szilard. As Szilard stated in his "Recollections," "it is not necessary to succeed in order to persevere." Szilard's political science in the post World War II era echoed this tragic principle of Szilard's life and science which reverberated and harmonized with the liberal political culture of the post-World War II era. In this sense, there can be no more dramatic display of the post war liberal scientific mythos than Leo Szilard's extra-political and tragic political science.

Notes

1. According to Alice Kimbell Smith, historian of the atomic scientists's peace movement, "Those who found Szilard's brand of intellectual ferment at all appealing were themselves infected with it, and a number of his younger colleagues say that he was the one who first led them to thinking about the political impact of what they were doing." Alice K. Smith, *A Peril and a Hope: The Atomic*

Scientists' Movement in America: 1945-47 (Cambridge, Mass.: M.I.T. Press, 1970): 27.

2. For Szilard' role in the peace movement see Alice Kimbell Smith, *A Peril and a Hope: The Atomic Scientists' Movement in America: 1945-47* (Cambridge, Mass.: The M.I.T.Press, 1970): 27.

For an account of his involvement in the Pugwash Conferences, the Angels Project, and The Council for a Livable World, see Helen S. Hawkins, G. Allen Greb, and Gertrude Weiss Szilard, eds. *Toward a Livable World: Leo Szilard and the Crusade for Nuclear Arms Control*, Volume III of *The Collected Works of Leo Szilard* (Cambridge, Mass. and London: The MIT Press, 1987). Hereafter cited as *Toward a Livable World*.

3. Barton Bernstein, "Introduction" in *Toward a Livable World*, lv.

4. Leo Szilard, "Are We on the Road to War," *Bulletin of the Atomic Scientists*, Vol. 18 (Ap., 1962): 28-29.

5. Szilard, "Disarmament and the Problem of Peace," *Bulletin of the Atomic Scientists*, 11(Oct., 1955): 297-307.

6. Leo Szilard, "How to Live with the Bomb and Survive-," *Bulletin of the Atomic Scientists*, Vol. 16(Feb., 1960): 59.

7. Leo Szilard, "Political Settlement," *New Republic,* Vol. 145(Oct. 9, 1961): 18.

8. For example, Alice Kimbell Smith's characterization of Szilard as "The Elusive Dr. Szilard," *Harper's Magazine* (July, 1960): 77-86. At times even his colleagues on The Council for a Livable World were hard pressed to corral Szilard's provocative political statements which were sometimes used against the Council to make it seem more radical than it really wanted to be perceived. See for instance the letters and articles sent to Szilard by H. Ashton Crosby, then Executive Director of The Council for a Livable World, in March of 1964, *Szilard Papers*, Box 6, Folder 35.

9. For Szilard's inspirational disconnectedness, see Michael Bess, "Leo Szilard: Scientist, Activist, Visionary," *Bulletin of the Atomic Scientists*, 41(Dec. 1985): 18. For his deliberate ignorance of American politics, see Bernstein, "Introduction" in *Toward a Livable World*, lxv.

10. Bernstein, "Introduction" in *Towards a Livable World*, lxi for a categorical examination of "Szilard".

11. Leo Szilard, "A Petition to the President of the United States," July 17, 1945 in *Leo Szilard: His Version of the Facts*, 211-212.

12. "President Truman Did Not Understand": an interview with Leo Szilard, *U.S. News and World Report*, Vol. 49(Aug. 15, 1960): 68.

13. Leo Szilard, "Atomic Bombs and the Postwar Position of the United States in the World- 1945," *Bulletin of the Atomic Scientists*, Vol. 3(April-May, 1947): 351-353.

14. For a good narrative account of these activities, see William Lanouette with Bela Szilard, *Genius in the Shadows: A Biography of Leo Szilard, the Man Behind the Bomb*. (New York: Charles Scribner's Sons, 1992): 262-277.

15. Szilard, "Calling for a Crusade," *Bulletin of the Atomic Scientists*, Vol. 3(Ap.-May, 1947): 103.

16. Hans Bethe; Harrison Brown; Frederick Seitz; Leo Szilard, "The Facts about the Hydrogen Bomb," *Bulletin of the Atomic Scientists*, Vol. 6(April, 1950): 107.

17. Szilard, "Calling for a Crusade," 102.

18. Szilard, "Atomic Bombs," 351

19. Szilard, "Atomic Bombs," 352.

20. Szilard, "Calling for a Crusade," 102.

21. Leo Szilard, "America, Russia and the Bomb," *New Republic*, Vol. 121(Oct. 31, 1949): 11.

22. Leo Szilard, "Disarmament and the Problem of Peace," *Bulletin of the Atomic Scientists*, Vol. 11(Oct., 1955): 298.

23. Leo Szilard, "Shall We Face the Facts," 270.

24. Leo Szilard, "Shall We Face the Facts," *Bulletin of the Atomic Scientists*, Vol. 5(Oct., 1949): 269.

25. Szilard, "Calling for a Crusade," 103.

26. Ibid., 104.

27. Ibid.

28. Ibid., 105.

29. Ibid.

30. Leo Szilard, "Can We Have International Control of Atomic Energy?" *Bulletin of the Atomic Scientists*, Vol. 6(Jan., 1950): 10.

31. Ibid., 11.

32. Ibid.

33. Ibid.

34. Ibid.

35. Szilard, "Disarmament," 299.

36. Leo Szilard, "How to Live with the Bomb and Survive-," *Bulletin of the Atomic Scientists*, Vol. 16(Feb., 1960): 59,72.

37. Leo Szilard, "Political Settlement," *New Republic*, Vol. 145(Oct. 9, 1961): 18.

38. Leo Szilard, "'Minimal Deterrent' vs. Saturation Parity," *Bulletin of the Atomic Scientists*, Vol. 20(Mr., 1964): 12.

39. Ibid.

40. Tristram Coffin, "Leo Szilard: The Conscience of a Scientist," *Holiday*, 35(Feb., 1964): 99.

41. Leo Szilard, "'Minimal Deterrent' vs. Saturation Parity," 12.

42. Letter from Szilard to Lord Bertrand Russell (May 23,1957), Document 31 in *Toward a Livable World*, 157.

43.Draft of a letter to the *Bulletin of the Atomic Scientists* (August 15, 1957), Document 32 in *Toward a Livable World*, 164.

44. Ibid.

45. Leo Szilard, "Memorandum Based on a Meeting Held on the Initiative of Bertrand Russell at Pugwash, Nova Scotia" (July 2, 1957), Document 36 in *Toward a Livable World*, 175.

46. Ibid., 176.

47. Ibid.

48. "Letter to the Editor of The Times of London" (March 17, 1958), Document 39 in *Toward a Livable World*, 191.

49. Ibid., footnote 3, 192-193.

50. Leo Szilard to N.S. Khrushchev (October 9, 1962), Document 60 in *Toward a Livable World*, 300.

51. Ibid.

52. Editors notes in *Toward a Livable World*, 260.

53. "Soviet Reply to Letter of July 15, 1963 (Undated), Document 70 in *Toward a Livable World*, 328.

54. Leo Szilard, "Are We on the Road to War?" *Bulletin of the Atomic Scientists* 18 (April 1962): 23-30.

55. The text of these speeches appears in an article entitled "Are We on the Road to War?" *Bulletin of the Atomic Scientists* (April, 1962): 23-30.

56. Ibid., 25.

57. Szilard originally used two names for the movement, Council for Abolishing War and Council for a Livable World. Ibid., 28.

58. Ibid., 29. Commentators on the Council, including Barton Bernstein and William Lanouette, have all failed to notice the significance of this distinction in Szilard's description of the Council. As a result, they have either been puzzled by the naivete of this bizarre political organization, or they have chastised Szilard for not wanting to get down to the nitty gritty of political organizing. Szilard's political science can be logically understood without either of these judgements by recognizing the significance of his distinction between political organization and political movement.

59. Ibid.

60. Leo Szilard, "Are We on the Road to War," *Bulletin of the Atomic Scientists*, Vol. 18(Ap., 1962): 28-29.

61. Leo Szilard, Draft of "The Council and the Lobby" (August 29, 1962) *Szilard Papers*, Box 32, Folder 15.

62. Ibid. and Leo Szilard, "The Next Step" (February 28, 1962), Document 86 in *Toward a Livable World*, 451.

63. Szilard, "Are We on the Road to War," 28.

64. Leo Szilard, "The Next Step" (February 28, 1962), Document 86 in *Toward a Livable World*, 451.

65. Ibid., 451-452.

66. Szilard, "*Der Bund*," 23.

CHAPTER FIVE
THE FICTION OF LEO SZILARD

The political science of Leo Szilard's *"Der Bund"* described a particular relationship between science and society using the rhetoric of the German youth movements of the Weimar era. In *"Der Bund"* Szilard's "tragic science" emerged as a powerful political force that later informed Szilard's social and political commentary in the post World War II era and shaped his political mythology of a scientific liberalism in the cold war era.

But Szilard's observations on politics and society were never limited by the academic boundaries of political science. While he wrote many articles for the *Bulletin of the Atomic Scientists* and many other articles on politics, Szilard never transcribed the utopian vision of *"Der Bund"* into the rhetoric of academic political science. Traditional political science assumed the socio-political nature of its (the) subject, including the author of a political argument. Szilard's political "science" required that the boundaries of traditional political rhetoric, transgressed by science and the scientist, emerge in more detail by recognizing the significance of tragic science--objective and transcendent. Szilard's political science sanctioned the objectivity of science and the ability of scientists to transcend social

and political boundaries. Science in this sense was "no place"--not a part of any particular time or place- and a "better place"--an objective arena beyond the context of politics.

Such a utopian comprehension of the role of science and scientists in the political arena required that Szilard circumvent traditional political rhetoric because it could not comprehend the importance of this utopian fiction concerning science. Therefore, Szilard most completely expressed his views on the political nature of his "tragic science" in his science fiction, as can be seen in this excerpt from his most famous science fiction story, "The Voice of the Dolphins":

> Political issues were often complex, but they were rarely anywhere as deep as the scientific problems which had been solved in the first half of the century. These scientific problems had been solved with amazing rapidity because they had been constantly exposed to discussions among scientists, and thus it appeared reasonable to expect the solution of political problems could be greatly speeded up also if they were subjected to the same kind of discussion. The discussions of political problems by politicians were much less productive, because they differed in one important respect from the discussions of scientific problems by scientists: When a scientist says something, his colleagues must ask themselves only whether it is true. When a politician says something, his colleagues must first of all ask, "Why does he say it?"; later on they may or may not get around to asking whether it happens to be true.[1]

In this chapter, the nature and literary context of Szilard's science fiction will be explored in order to display his understanding of the transformative power of

science and its role in society.

Throughout his life, Szilard embraced science fiction as an alternate rhetorical style for social and political commentary. As a child and as an adult, the work of H.G. Wells, Edward Bellamy and other science fiction writers fascinated him.[2] Szilard viewed his political treatise, "*Der Bund*," as harmonizing with the political discussions of H. G. Wells's in *The Open Conspiracy*. In Szilard's "Recollections" he mentioned H. G. Wells's *The World Set Free* as an important influence in the intellectual exercise which led him to nuclear physics and fondly recalled his discussions with Otto Mandl, a timber merchant and German publisher of Wells's work.[3] Mandl and Szilard met in Berlin sometime in 1932 and discussed Wells's fiction and ways in which Man might be saved from "a series of ever-recurring wars that could destroy it." Mandl maintained that humanity needed a task that would satisfy its appetite for heroism and "the need to fight and encounter danger." He decided that Man must "launch an enterprise aimed at leaving the earth."[4] This conversation characterized Szilard's fascination with the fantastic ideas that he encountered while reading science fiction.

After World War II, Szilard wrote science fiction himself. In 1949, a peculiar story about aliens visiting "Grand Central Terminal" after the destruction of the earth

by nuclear war appeared in *The University of Chicago Round Table*.[5] Later in that same year, *The University of Chicago Law Review* published a political satire about the war trial of a scientist who worked on the atomic bomb entitled "My Trial as a War Criminal."[6] Both short stories, along with two other stories, "Calling All Stars" and "The Mark Gable Foundation"--written but not published in the late 1940's--later appeared in the book *The Voice of the Dolphins and Other Stories* (1961).[7] In 1950, a semi-autobiographical story appeared in the *Bulletin of the Atomic Scientists*, "The Diary of Dr. Davis."[8] The *Bulletin* later also published his bizarre story on nuclear war strategy, "The Mined Cities," in 1961.[9]

The title story of his collection of short stories, "The Voice of the Dolphins," was his best-known science fiction short story. The book was issued by publishers in Britain, Italy, France, Japan, Germany, Argentina and Denmark in the early 1960s. The story was even made into a German play, "Die Stimme der Delphine," by Walter Knaus.[10] Inspired by the research on dolphin language skills by Dr. John C. Lily, an NIH marine biologist, "The Voice of the Dolphins" sketched a future history, recounting the changes in society caused by man's ability to communicate with dolphins from 1960 to 1988.[11] The superior intellect of the dolphins, put to use by scientists, enabled the world to escape nuclear destruction and sign a general disarmament

agreement in 1988.

"The Voice of the Dolphins" and many of Szilard's other short stories recalled the narrative voice of Julian West in Edward Bellamy's *Looking Backward*. Bellamy, an American democratic socialist, was very popular in late nineteenth and early twentieth century Europe, and *Looking Backward* was translated into most European languages, including Hungarian. There were three different Hungarian translations available in the 1890's. Six Hungarian editions appeared from 1891 to 1921, and four of these editions were published by Franklin Publishing House.[12] As did many in the late 19th century, Szilard read Bellamy's book when he was a young child.

This anecdotal connection does not fully describe the relationship between the Szilard's science fiction and *Looking Backward*, however. Bellamy's novel displayed a certain narrative stance toward time, science and society that identified him as one of the originators of twentieth century utopian science fiction. Bellamy's literary stance entailed a futuristic approach to history in which a historical narrative traced social, political and scientific developments from the past to the present--the present being the future--utopian society, developed and maintained by science. It might best be described as future history. As the father of this science fiction genre, then, a discussion of Bellamy outlines the literary context of Szilard's future

histories.

In Walter Bellamy's *Looking Backward*, the character Julian West reminisced about the past hundred years from the perspective of the year 2000. But his perspective was a unique one, since he was a man born in Boston, Massachusetts in the 1857 who awakened in the year 2000 from a deep sleep induced by the manipulations of a mesmerist in the previous century. He awakened to find himself in the care and company of Dr. Leete and his family, established residents of Boston in the year 2000.

Incredulous at his situation, Julian West explored Boston in the year 2000 and carried on long, detailed conversations with Dr. Leete. He could scarcely believe that Boston as it existed in the year 2000 developed from the Boston that he knew in the late nineteenth century, and he wanted to understand what society was like in the year 2000, and how it got that way. As Julian West learned how efficiently and justly society was organized in the year 2000, he began to appreciate the problems of late nineteenth century society and to understand how society had been transformed into something better. With this realization, a sense of melancholy and loneliness overtook him: "The past was dead, crushed beneath a century's weight, and from the present I was shut out. There was no place for me anywhere. I was neither dead nor properly alive."[13] He escaped this melancholia by discovering the love that he felt for Dr.

Leete's daughter Edith who, he learned, was the great granddaughter of Edith Bartlett, the women that Julian had planned to marry before he fell under the spell of the mesmerist.

Just as the continuity of this love relationship revived Julian's sense of belonging, awakening him to the reality of the connection between the world he left and the world in which he found himself, he fell asleep again and awakened in another world--Boston of 1887. Uncomfortable in his old surroundings, he pleaded for people to recognize the injustice around them.

> I have been in Golgotha, at last I answered. I have seen Humanity hanging on the cross! Do none of you know what sights the sun and stars look down on in this city, that you can think and talk of anything else? Do you not know that close to you doors a great multitude of men and women, flesh of your flesh, live lives that are one agony from birth to death?[14]

But the people did not heed him, and he despaired that his vision of the year 2000 had been nothing more than a dream. Suddenly, he awoke to find himself back in Dr. Leete's house: "my return to the nineteenth century had been a dream, and my presence in the twentieth century was the reality."[15]

If we examine the literary technique of *Looking Backward*, it becomes clear that the dialogue between Julian West and Dr. Leete unfolded a narrative account of the history that separated late nineteenth century society, as represented by Julian West, and the utopian society of the

year 2000, as presented by Dr. Leete. Through his looking backward technique, Bellamy illustrated the evils of late nineteenth century society--greed, unrelenting individualism, exploitation of the working masses, nationalism--and the good characteristics of society in the year 2000--community orientation, economic justice, and internationalism. The technique of looking backward allowed Bellamy to contrast the society of 1887 and the utopia of the year 2000. This critical narrative posture, presented as a historical account, carried the weight of historical fact. Bellamy's utopian society then acted as a historical reality from which 1887 could be represented in a critical way, bringing back life from the future to a past that was dead and a present that had been crushed by the weight of the preceding centuries.[16]

The point of this critical stance was transformation. The most obvious transformation presented in *Looking Backward* was the development of society. Society had developed out of its primitive laissez faire, capitalistic organization in the late nineteenth century and into a socialistic, scientifically managed society, free of the greed and exploitation of its predecessor. In the future society, people were cared for according to their needs and were required to give according to their ability. Money had been replaced by a credit card system. The antagonism between labor and capital had been replaced by socialistic

cooperation, and the needs of all were insured by developments in science and technology.[17]

A romantic transformation of the self accompanied this social transformation in *Looking Backward*. When Julian West reawakened in the utopian society of the year 2000, he mused that he was not worthy of such good fortune. He did not think that he had done anything to deserve his fortunate predicament. At that moment an inner voice spoke to him and comforted him with the knowledge that he was worthy because his "pleading for crucified humanity with a scoffing generation" signaled his personal transformation.[18]

In his early stories of the late forties, Szilard employed Bellamy's technique of looking backward specifically to criticize society in the nuclear age and bring about a transformation in how people thought about nuclear weapons. In "My Trial as a War Criminal," Szilard himself appeared as a character on trial for his life in a post World War III world:

> I was just about to lock the door of my hotel room and go to bed when there was a knock on the door and there stood a Russian officer and a young Russian civilian. I had expected something of this sort ever since the president signed the terms of unconditional surrender and the Russians landed a token occupation force in New York. The officer handed me something that looked like a warrant and said that I was under arrest as a war criminal on the basis of my activities during the Second World War in connection with the atomic bomb.[19]

In "My Trial," Szilard recounted World War III, a

bacteriological attack on New Jersey, and the capitulation of the United States to the Soviet Union. As he feared, the protagonist found himself under arrest for war crimes because he had helped design the atomic bomb. In a Nuremburg style trial, Szilard, Secretary of War Stimson, Secretary of State Byrnes, and President Truman defended themselves against the charges of "violation of the customs of war" and planning a war in violation of international agreements. All except Szilard, who defended himself by telling the truth about his opposition to the use of the bomb, explained their actions in much the same way the Nazi war criminals had done at Nuremberg. Mr Stimson pleaded "ignorance" of the knowledge that the Japanese were about to surrender. Truman maintained his innocence by arguing that he had merely "followed advice," and Mr. Byrnes justified his aggressive statements against Russia by arguing that he had not meant to imply in his statements that the U.S. should engage in an illegal war against Russia. According to Byrnes, military action against Russia was not implied by his phrase "measures of last resort." If he had really meant to advocate an illegal war, he would have said "measures of very last resort."

All of these defenses would have been rejected by the tribunal, of course, and the men put to death, but fate intervened. The vaccine that the Russians had counted on to counteract the fatal virus they used against the United

States failed. In the resulting bacteriological apocalypse, a new postwar settlement was reached, ending the war trials.

The fictional narrative of "My Trial" highlighted Szilard's criticisms of the United States government's use of the atomic bomb against Japan. Szilard pointed out the hypocrisy of the United States using the atomic bomb against innocent civilians and holding war crimes trials against the Germans, and his future history warned of the dangers of winning a war through technological means. That very same technology, the atomic bomb or the Russian virus of World War III, could come back to destroy, according to Szilard's story.

When aliens landed on earth in Szilard's "Report on 'Grand Central Terminal,'" they found just such a destroyed earth:

> You can imagine how shocked we were when we landed in this city and found it deserted. For ten years we were traveling through space, getting more and more impatient and irritable because of our enforced idleness; and then, when we finally land on Earth, it turns out--as you have undoubtedly heard--that all life is extinct on this planet.[20]

The aliens then tried to piece together what had happened by carefully studying the terminal. They discovered that the primitive transportation vehicles were divided into smoking and non-smoking areas, leading the aliens to conclude that society was very segregated. Obviously people with smokey complexions had been put in one area and those with a non-smokey complexions in another. They also concluded that

earth dwellers had very elaborate ceremonies for depositing their excrement. They discovered this by examining the hidden depositories in the basement of the terminal which required a ceremonial disk. This led one bright alien, Xram (Marx), to conclude that such ceremonies were probably common in earthly society and that such ceremonial coins were most likely also required for getting food and for all other social activities. Such an economic organization, Xram concluded, probably led to the war which destroyed all life.

Unfortunately for Xram, the observation that several lodges did not contain this ceremonial gadget at their excrement depositories totally disproved his wonderful theory. A relieved alien leader then concluded:

> I am glad that we were able to clear this up in time, for I should have been sorry to see Xram make a fool of himself by including his theory in the report. He is a gifted young man, and in spite of all the nonsensical ideas he can put forward at the drop of a hat, I am quite fond of him.[21]

In addition to adopting Bellamy's critical stance in future history, Szilard's keen alien observer who narrated the excavation of "Grand Central Terminal" displayed Bellamy's ambivalence toward capitalistic and Marxist organized society. Szilard's clever application of Marxist interpretation to pay toilets was both a playful indictment of capitalistic society and a satirical representation of the Marxist understanding of capitalistic society. The pay toilet illustrated the absurdities of capitalism which could lead to the destruction of life on earth. The extrapolation

from pay toilets in Xram's analysis satirized Marxism's simplistic and narrow understanding of capitalistic society. Both led to the extinction of the human race as observed by Szilard's alien narrator, whose critical viewpoint existed somewhere outside of selfish capitalism and simplistic Marxism.

Szilard used another alien voice in "Calling All Stars" to communicate his concern over nuclear war:

> Calling All Stars. Calling all stars. If there are any minds in the universe capable of receiving this message, please respond. This is Cybernetica speaking . . . an emergency has arisen and we are in need of counsel and advice . . . . We have observed on Earth flashes which we have identified as uranium explosions.[22]

This time it was the radio voice of Cybernetica, a planet inhabited by a race of electronic minds "housed in a steel case" and equipped with microscopes and telescopes as sensors and two robots, one for maintenance and the other to carry out the will of the mind. The sole purpose of this race was to think. They did not know why they thought, but they followed an "innate urge," constantly creating problems to think about. The minds of Cybernetica had observed earth and concluded that it might be possible that a primitive organism with a "low grade mind" might have developed on earth that was capable of creating uranium bombs. Such minds, it was believed, may not be "subject to the laws of reason" and were, therefore, quite a danger. The people of Cybernetica were begging for someone to respond if they had

any knowledge of the irrational creatures on earth.[23]

The puzzlement and fear of the Cybernetica exhibited Szilard's dissatisfaction with the present--post World War II--nuclear world and was reminiscent of the alienation that Julian West felt when transported back to the present--late nineteenth century--in Bellamy's *Looking Backward*. The thinkers of Cybernetica felt the same sense of despair that Julian West felt as he looked at the nineteenth century from the alien perspective of the utopian future. Disturbed by what they saw, the cybernetica pleaded for help. In Szilard's short story, there was no response, reflecting the sense in which the early writings of Szilard, looking backward at the events of World War II and particularly the development of nuclear weapons, had no place to go. They remained in the present as an alienated voice. They needed the future. Without it, there was no place from which anyone could respond, so Szilard created a dystopic future to warn humanity about the dangers of the present.

In "The Mark Gable Foundation," Szilard created a maniacal future that magnified his fear of technological advancement. Reminiscent of Bellamy's mesmeric dream in *Looking Backward*, in Szilard's story, a scientist discovered a process for putting people into a state of suspended animation and proceeded to "withdraw from life" for three hundred years:

> I always wanted to see what kind of place the world will be three hundred years hence. I

> intended to "withdraw from life" (as we proposed to call the process) as soon as we had perfected the method and to arrange for being returned to life in 2260.[24]

Rudely awakened by his lawyers after ninety years, the scientist confronted a world on the verge of a nervous breakdown. Teeth had been replaced by chewer plates, and it was considered unstylish and unsightly to have teeth. Most children were the product of the union of a mother and the latest TV superstar sperm donor, and the unemployed, at federal expense, "withdrew from life." Millions of others "withdrew from life" hoping to wake up to a cure for cancer or cured from their marriage through the death of their spouse. Clearly, in Szilard's future, technological advancement had overwhelmed social progress.

At a dinner party in this withdrawn world, the scientist met the latest sperm donor superstar, Mark Gable. Mr. Gable had earned millions of dollars and wanted to contribute to the happiness of mankind. He and the scientist agreed that what must be done to improve mankind was to inhibit scientific progress temporarily so that society could catch up. The scientist suggested that a foundation be set up that paid the best and most productive scientists to serve on committees and hand out research awards, similar to those of the National Science Foundation. This, the scientist suggested, would curtail scientific development by keeping the best scientists busy on committees and by channeling scientific research into fashionable, result

oriented research areas, making science into something like a parlor game.

The scientist decided to stay in this time and work for this worthy goal, despite having to get his teeth extracted: "All of my life I have been scared of dentists and dental extractors, and somehow I suddenly became aware of the painful fact that it was not within the power of science to return me to the twentieth century."[25] There was no going back to the present now. Science had taken him, had taken them all, into the future, but it could not take them back. The monster of technological advancement had led to a manic world out of control in which science had to be stopped. The necessary scientific utopia, so characteristic of Bellamy, had been replaced by a bizarre Szilardian dystopia.

In a story entitled "The Mined cities" published in the *Bulletin of the Atomic Scientists* in 1961, Szilard returned to the suspended animation theme to present another disquieting picture of a world suffering under the burden of nuclear war:

> A: No thank you. No more water, please. What year did you say it was?
>
> B. 1980, Dr. Jones. You have been asleep for 18 years. I know what you are going to ask me next; please rest assured your cancer of the pancreas is as good as cured; homotoxin is going to do the trick.[26]

In this story, Szilard eavesdropped on a discussion between the generic Dr. Jones and the anonymous Dr. "B" who were discussing the peculiar character of American life in 1980.

Many Americans lived in mined cities that had nuclear bombs underneath them manned by citizens of Russia. Similar cities, manned by American citizens, existed in Russia. In Szilard's dystopian future, this peculiar system had been set up to deter nuclear war after a series of political crises and the economic burden of a nuclear arms race had become apparent. All of this was related to Dr. Jones in a matter of fact tone by the mysterious doctor who ended his description of the dystopian future world by telling Dr. Jones that all of this had been predicted by Leo Szilard in *The Voice of the Dolphins*.[27]

The dystopian nature of Szilard's "The Mark Gable Foundation" and "The Mined Cities," defied the utopian transformation of science and society envisioned by Bellamy. They looked beyond Bellamy's *Looking Backward* and recalled the dystopian novels of H. G. Wells, one of Szilard's favorite authors. Wells employed Bellamy's looking backward technique in a different way as shown by one of Szilard's favorites and a science fiction classic, *The Time Machine*. In this story, Wells told the story of the future of the world and the human race from the perspective of a scientist--"the time traveller"--who had developed a machine that could travel through time. He used that machine to travel to the remote future of the year 802,701 A.D. and back, recalling his adventure to skeptical friends, one of

whom was the anonymous narrator of the story. Wells's dystopian future history unfolded in the "time traveller's" narration of his observations and activities in the future. As the "time traveller" recalled his future history to an incredulous audience upon his return, his understanding of the future opened up a prophetic space in the present, allowing for a critical analysis of the present by the impersonal narrator who was forced to confront the negative prophecy of the "time traveller."

Wells critique of the present revolved around the "time traveller's" discovery of a future world inhabited by two descendants of the human race, the "Eloi" and the "Morlocks." The Eloi lived above ground in a peaceful, Garden of Eden existence. The Morlocks were ugly, cannibalistic creatures that lived underground. Observing this remote world, the scientist gradually came to understand how these two types of human beings had developed out of the industrial world of his time. The Eloi, descendants of the aristocracy of the industrial early twentieth century, lived a primitive, carefree life in harmony with nature, without strife and without striving. Theirs was a homogeneous, stale lifestyle, the product of a general degeneration in the size, strength and intelligence of the upper classes in early twentieth century Europe. The Morlock, descendants of the working class, inherited and took care of the technology of the past, becoming, in the

process, slaves to machines which they operated but did not understand. This human devolution accompanied the natural devolution of the world in the "time traveller's" future history. The "time traveller" went beyond 802,701 A.D. to the end of the world where he saw in all its devastating beauty the thermodynamic death of the earth:

> I stopped very gently and sat upon the Time machine, looking round. The sky was no longer blue. North-eastward it was inky black, and out of the blackness shone brightly and steadily the pale white stars. Overhead it was a deep Indian red and starless, and south-eastward it grew brighter to a glowing scarlet where, cut by the horizon, lay the huge hull of the sun, red and motionless.[28]

In depicting this social and natural devolution, Wells presented a critical view of the early twentieth century that had lost faith in the utopian vision of the industrial future. Looking backward, Wells's *Time Machine* transported the reader to a dystopian space, more critical of the present and determined by its apocalyptic future history. The impersonal narrator of the "time traveller's" tale reinforced the impersonal nature of the march of human history toward an apocalyptic future, but, at the same time, introduced a tragic character driven by the apocalyptic vision of the "time traveller":

> He [the time traveller], I know--for the question had been discussed among us long before the Time Machine was made--thought cheerlessly on the Advancement of Man-kind, and saw in the growing pile of civilization only a foolish heaping that must inevitably fall back upon and destroy its makers in the end. If that is so, it remains for us to live as though it were not so. But to me the future is still black and blank--is vast

> ignorance, lit at a few casual places by the memory of history.[29]

Szilard's science fiction displayed this same tragic character. It first emerged in a short piece entitled "The Diary of Dr. Davis" published in the *Bulletin of the Atomic Scientists* in February of 1950. The prologue to the story, written by a future publisher in 1980, recapitulated the story of the diary. Dr. Davis was a famous atomic scientist who had helped develop the atomic bomb in World War II. Unfortunately, he suffered an injury to his head just prior to the Republican convention of 1948 and remained in the hospital the rest of his life, closed up in his room, unable to stand the light of day. The doctors never really decided what was wrong with him. Some said he had a physical problem, the result of his concussion. Others said all of his symptoms came from a psychosomatic neurosis brought about by his sense of guilt in developing atomic energy. Whatever the cause, Dr. Davis did nothing but read, carry on a few conversations with an aide to Wendell Willkie, and write in his diary until his death. The editors noted that the significance of this diary lay in its showing how the destruction of World War III and IV could have been avoided "if the statesmen had had as much insight into the problems of the world as the intelligentsia of those days."[30] Dr. Davis himself died in a nuclear explosion over Stagg Field in Chicago in World War III.

> Dr. Davis was not a man of exceptionally great imagination; there is reason to believe that he did no more than to record the commonsense views of his more enlightened contemporaries. His somewhat clumsy style does not make the Diary easy reading, but the student of political ideas may be rewarded by a deeper understanding of modern political thought, which can be acquired through the study of its forerunners.[31]

Dr. Davis and Willkie's aide discussed political issues associated with the atom bomb and the relationship between the United States and the Soviet Union. They examined how disarmament and peace could be achieved between the United States and Russia by the establishment of a world government. The details of the political arguments were clever and visionary and were meant to reflect a certain common sense approach to the political problems of the post World War II era. The third person introductory narrative, however, transformed the Diary and the character of Dr. Davis into a quixotic capitulation to a nightmarish future of nuclear war. Dr. Davis became a tragic visionary figure misunderstood by those of his day or, even worse, written off as a neurotic eccentric, who died by the hand of his own creation, the atomic bomb. Like the "time traveller" who had seen the thermodynamic death of the world and retreated into some unknown time, Dr. Davis retreated from the disastrous reality which he had fashioned into the safety of his own fantasies. He even refashioned time to suit his psychological needs. Cut off from sunlight, he lived on a sixteen hour cycle that enabled him to cram 15 years into

his Diary in only ten years. Even time had become subordinate to the vision of the diary which travelled through time only to be discovered by the publisher in 1980. "The Diary of Dr. Davis" existed in this visionary past, present and predetermined apocalyptic future, all of which depended on the tragic character of Dr. Davis.

Recognizing the tragic character of "The Diary of Dr. Davis" has displayed the sense in which Szilard's science fiction hinged on a dystopian vision to criticize the political reality of the post World War II era. There was a sense in which Szilard's apocalyptic visions escaped from the constraints of the political stalemate of the post war period through a recognition of the apocalypse. His stories depended on this vision. The vision itself was a kind of cathartic experience which created the possibility of a future, dim and black perhaps, but transformed by the recognition of the nuclear apocalypse. This critical stance, informed by the apocalyptic vision, offered a chance for political, social and personal transformation. It allowed for a new political voice transformed by the vision to emerge in the silence of the dangerous and divisive age of political stalemate and the nuclear arms race, a voice which could set the world free, a voice that reverberated the call of H.G. Wells's *The World Set Free*. While he was considering what direction he wanted to take in nuclear physics in Berlin in 1932, Szilard read this book:

> This book was written in 1913, one year before the World War, and in it H. G. Wells describes the discovery of artificial radioactivity and puts it in the year 1933, the year in which it actually occurred . . . This book made a very great impression on me, but I didn't regard it as anything but fiction.[32]

Wells's book pictured a professor who held his lecture audiences spellbound as he described the incredible possibilities which might open up if humanity could harness the powers which enabled radium and other naturally radioactive substances to disintegrate:

> "Why does only a minute fraction of the radium disintegrate in any particular second? Why does it dole itself out so slowly and so exactly? Why does not all the uranium change to radium and all the radium change to the next lowest thing at once? Why this decay by dribbles; why not a decay <u>en masse</u>? . . . Suppose presently we find it is possible to quicken that decay?" . . . "Given that Knowledge," he said, "mark what we would be able to do!"[33]

A young lad by the name of Holsten picked up on this notion and eventually discovered atomic energy in 1933. Inspired and haunted by the possibilities of his discovery, he released his papers, beginning a gradual technological revolution that would culminate in the 1950s. In 1953, the atomic energy engine revolutionized industrial production. Various atomic energy engines emerged in all branches of industrial development, resulting in a dramatic transformation of society. In transportation, for example, the atomic energy engines superseded all other combustion engines, and their power and weight made them ideally suited for aircraft design. This led to "the epoch of the Leap into

the Air," an age in which the production of atomic powered aircraft, including helicopters, increased dramatically.[34]

Unemployment and social division also increased dramatically, however, as the new technology made old industries and old skills obsolete. Coal mines and steel mills closed. The petroleum industry and all the other industries attached to it collapsed. The financial markets struggled as gold, a byproduct of the atomic energy machines, depreciated rapidly. The numbers of unskilled or under-skilled laborers increased with most being flung into unemployment. In 1955, under such dreadful conditions, the suicide rate in the United States quadrupled and violent crime increased around the world. The new source of energy had turned the world into a shambles.

Soon thereafter, an atomic world war erupted. Aeroplanes dropped devastating atomic bombs on helpless millions all over the world:

> Those [bombs] that were thrown from aeroplanes fell in this state, they reached the ground still mainly solid and, melting soil and rock in their progress, bored into the earth. There, as more and more of the Carolinum became active, the bomb spread itself out into a monstrous cavern of fiery energy at the base of what became very speedily a miniature volcano.[35]

The atomic bombs literally pounded the world into submission while a clever French ambassador by the name of Lablanc gathered the world's leaders together to put an end to nuclear war. The world leaders established a "World Republic," and the old capitalistic system, disrupted by the

war, was largely replaced by an economic system based on social cooperation. A new culture emerged as well in which "man the warrior, man the lawyer" was replaced by "man the curious dreamer and man the creative artist."[36]

> The catastrophe of the atomic bombs which shook men out of cities and businesses and economic relations shook them also out of their old established habits and thought, and out of the lightly held beliefs and prejudices that came down to them from the past. To borrow a word from the old-fashioned chemists, men were made nascent . . .[37]

The tragic character of *The World Set Free* emerged in its presentation of the role of science in the process of social and individual transformation. In the preface Wells emphasized that science necessitated social and political transformation, and he explicitly stated that this was what the story of *The World Set Free* was all about. The controlling impersonal narrator of the story also constantly focused attention on this issue. In the first chapter, the impersonal narrator described how scientific and technological developments had driven the history of humanity because "The History of Mankind is the history of the attainment of external power."[38] The story of mankind, we are told, was ultimately the story of Man, "the tool-using, fire-making animal" whose life had always been and always would be transformed by the tools which he used to survive and which gave him "external power." The impersonal narrative voice of the first chapter, "The Sun Snarers," and the continuous control which that narrative voice had over

the account of the development of atomic energy defined the parameters of the story.

Within those parameters, the tragic characters of the story emerged. First, Holsten struggled with his humanity as he pondered releasing his knowledge about atomic energy to the world:

> He reassured himself against the invasion of this disconcerting idea that the was something strange and inhuman, a loose wanderer from the flock returning with evil gifts from his sustained unnatural excursion amidst the darkeners and phosphorescence beneath the fair surfaces of life.[39]

Holsten escaped his dilemma by realizing that if he did not do it, someone else would and that he could not be responsible for "consequences I cannot foresee."[40]

The narrator quietly presented the disastrous consequences of Holsten's discovery in the account of "The Last War" through the eyes of a young officer's *Wanderjahre*. The idealistic young officer, Frederick Barnet, wrote in his *Wanderjahre* of "the escape from individuality in science and service and his discovery of this 'salvation'" while at the same time witnessing the horrors of the last war.[41] He represented, according to our narrator, a certain idealism that led to the transformation of society, the link between the past and the future, smashed by atomic war.

The tragic character of Marcus Karenin arose out of the atomic devastation in the last chapters of *The World Set Free*. Karenin expressed the new philosophy of a new phase in

human history, according to our narrator. High in the Himalayas, the visionary Karenin shared his thoughts with a few friends as he awaited surgery at a remote surgical center. Prior to the war, explained Karenin, scientists were few in number and allowed to do only what lawyers and politicians asked them to do because they were afraid of the vision of science. They were afraid that science would change their lives and undermine their power. In the new phase, science was no longer contained: "Science is no longer our servant. We know it for something greater than our little individual selves. It is the awakening mind of the race."[42] In the new phase of human history, a time likened to that of classical Athens and Renaissance Florence, man recognized his power, and the possibilities of mankind seemed endless: "'But as I sit here and dream of the possibilities in the mind of man that now gather to a head beneath the shelter of peace, these great mountains here seem but little things.'"[43] Man, the tool user, had finally snared the sun and by so doing had realized his power and achieved a sense of immortality. Inspired by this vision, Karenin howls at the sun:

> 'Very soon now, old Sun, I shall launch myself at you, and I shall reach you and I shall put my foot on you spotted face and tug you about by your fiery locks . . . Old Sun, I gather myself together out of the pools of the individual that have held me dispersed so long. I gather my billion thoughts into science and my million wills into a common purpose. Well may you slink down behind the mountains from me, well may you cower.'[44]

A few days later Karenin died from complications from his surgery. Marcus Karenin, like the cultural immortals of Athens and Florence, could not escape death, but his scientific vision secured for him a kind of immortality. In the new phase of human history, the world recognized the voice of Marcus Karenin as the voice of all men who sought the collective wisdom of mankind through science. These men of science set the world free.[45]

Wells's characterization of science in *The World Set Free* recognized a tragic duality for science. Science and scientists were the destructive and creative forces which determined the history of mankind. Science, as the manifestation of humanities striving for control over nature, implied the introduction of new means of power. This inevitably meant that science would lead to the ever increasing destructive power of man, such as the devastation of atomic warfare. Along with this destructive power came the power of transformation as well. Science and scientists created a new society in which mankind was re-born. Science now had the tragic power over life and death, a power previously assigned to god or gods in the history of mankind. The proud and defiant voice of Marcus Karenin proclaimed that new power, and the impersonal narrator related this almost biblical story of mankind and how mankind was set free by embracing the vision of this all powerful science.

Szilard's fiction echoed Wells's tragic vision of a powerful science that transformed the world in his most celebrated story, "The Voice of the Dolphins." This was most clearly illustrated in this short story by a fictional biological research institute in Vienna that served as the foundation of the story line:

> In retrospect, it would appear that among the various recommendations made by the President's Science Advisory Committee there was only one which has borne fruit. At some point or other, the Committee had recommended that there be set up, at the opportune time, a major joint Russian-American research project having no relevance to the national defense, or to any politically controversial issues. The setting up in 1963 of the Biological Research Institute in Vienna under a contract between the Russian and American governments was in line with this general recommendation of the committee.[46]

Szilard's fictional institute studied Dolphins and quickly learned to communicate with them. Researchers at the institute discovered that dolphins were more intelligent than man and lacked only the factual information that tactile humans could provide before being able to offer brilliant scientific insights and political guidance.[47]

The dolphins' first scientific success came in the field of biology. The dolphins suggested the development of a mutant algae that was both a good protein food source and a birth control drug, called "amruss." The profits from this great discovery enabled the institute to fund itself independently of America and Russia and to invest in activities which influenced political developments around

the world. The institute invested in numerous television stations which were free of commercial activity and slavish attention to the "taste of morons." In other words, they had no advertising. Instead, they broadcast programs such as "The Voice of the Dolphins," a program devoted to political problems and clarifying "what the real issues were."

As the world struggled to contain the nuclear arms race and prevent nuclear war, the dolphins, with the help of institute staff, worked quietly but effectively to change the political structure of the world. The mined cities idea saved the world from destruction in 1970 when a communist revolution in Iraq threatened to disrupt political stability. In the United States, the Viennese institute secretly set up and funded the "American Research Foundation" (ARF). This political think tank quietly altered the American political scene by offering certain governmental officials, who did <u>not</u> pursue a constructive foreign policy, a $200,000 salary to sit on the board of the ARF. Government officials who favored a constructive foreign policy, however, were never offered a position on the board and continued to serve in the government. In this way the United States slowly shifted toward a more constructive foreign policy aimed at disarmament.[48]

Between 1980 and 1985, the world came very close to destruction. A united Germany (as of 1980), threatened to retake parts of Poland. A revolution in South Africa, put an

all black government in power. China had become a nuclear power, and a continuing arms race increased the instability of the balance of power between the West and Russia. In Japan, economic difficulties brought the militarists back into power. Concern began to mount that a belligerent Germany or Japan might launch an anonymous nuclear attack on an American city, which, in turn, might provoke an attack on Russia by the U.S. and bring about a nuclear war between the U.S. and Russia.

The fear of nuclear war was so great in the U.S. that wealthy people began to move to Arizona and New mexico and build elaborate homes equipped with bomb shelters. People also moved their money into neutral countries like Switzerland. As capital left the country, the price of gold went up, and economic instability slowly became the most important issue in American politics. Politicians split between those that favored a multi-billion dollar bomb shelter building campaign and very inconvenient and costly city evacuation drills, and those that favored of a move toward disarmament.

The economic and social burden of the arms race, however, slowly convinced many in America to move toward disarmament, and in 1987 an informal conference convened in Vienna under the auspices of the dolphins. The disarmament negotiations were carried out by a steering committee composed entirely of the staff members of the institute.

This was justified by the fact that only the staff members could actually communicate with the dolphins.

The steering committee opened the coference by suggesting that an overall disarmament process be worked out first before any complicated political problems related to the current crises were addressed. On the topic of monitoring the disarmament process, the Russians proposed a system whereby ordinary citizens informed the government of any breech of the disarmament agreement. Citizens were told that it was their patriotic duty to see that the agreement be enforced and that anyone who exposed a breech of the agreement would be rewarded with a million dollars. The Americans agreed that this would work in the U.S. as well, but the money would, of course, have to be tax free. They also agreed that the arrest or shooting of an informant would be considered a violation of the agreement.

Participants at the conference also came to agreement on the nature of the disarmament process. It would be a gradual "controlled-arms reduction." While not insuring total disarmament, this process reduced the danger of clashes between the great powers. There were to be various stages of reduction with each stage set by the U.N. Security Council. Funds saved by each country due to disarmament were to be set aside in the "Fund for Compensation." This fund reimbursed any country for economic losses it sustained by invoking economic sanctions against a country which withdrew

from the disarmament agreement.

As for the political complications of Europe, the chief stumbling block to any disarmament program, the conference entertained a proposal by the dolphins that the major aim should be the political and economic integration of Europe. Starting with France and Germany, this process would begin by allowing citizens of both countries to serve in the parliamentary bodies of each country. At first five percent of the French parliament would be composed of Germans and vice versa for the German parliament. Gradually this percentage would be increased until both counties were politically integrated. A similar process would then be used to integrate all of Europe. Naturally, all parties at the conference were skeptical of this proposal and on that skeptical note the conference adjourned.

Four months later, governmental negotiations began. Slowly, Russia, the United States, and China worked out a disarmament agreement along the lines proposed at the conference. Gradually arms were being reduced when suddenly Russia made an extraordinary proposal. They suggested that Poland gradually cede land to Germany on its western border, and it would do the same on Poland's eastern border. Any dislocation caused by this process would then be paid for out of the "Fund for Compensation," which had been building up as the great powers disarmed. This led to a split in the militaristic "People's Party" in Germany. Half wanted to

sign on to the agreement and half did not. This political chaos allowed the dolphins' proposal on French representation in the German parliament to pass in the German parliament. Gradually as the percentage of French representation in the German parliament increased, the dominance of the "People's Party" decreased, bringing stability to Europe. At the same time, regional international military forces, under the auspices of the U.N. were agreed upon, and these forces set up regional security forces in Central Africa, the Middle East, Southeast Asia and Central America.

"The Voice" of the dolphins had led the world to virtual total disarmament. In this safer world, where money was not wasted on arms, the world economy flourished. The annual American income increased $20.00. Paid vacations in Russia lengthened to three months, and third world countries developed their economies. The dolphins at the Vienna Institute passed away, however, killed by a mysterious virus. A little later the institute burned down, and, although other scientists tried to communicate with the dolphins again at an institute in Munich, they never succeeded, and the glorious discoveries of the Vienna Institute came to an end. The inability of other scientists to communicate with dolphins prompted some inquiries into exactly what had transpired at the Institute and led many to speculate that there never was any communication with the

dolphins. Despite this skepticism "The Voice of the Dolphins" concluded:

> It is difficult to see, however, how the Vienna Institute could have accomplished as much as it did if it hadn't been able to draw on considerably more than the knowledge and wisdom of the Russian and American scientists who composed its staff.[49]

In the narration of this tragic ending to "The Voice of the Dolphins," the tragic character of Szilard's science fiction has emerged more clearly than in the narrative voice of the 1980 publisher that described Dr. Davis in "The Diary of Dr. Davis." While looking backward in the style of Edward Bellamy, "The Voice" of the dolphins was more abstract than in *Looking Backward* or any of Szilard's other short stories. There was no first person account present as in "My Trial as a War Criminal" or "The Mark Gable Foundation." Even the personal dialogue of Julian West and Dr. Leete, depicted by discussions between Dr. Davis and Sidney Curtis in "The Diary" or the more impersonal dialogue between Dr. Jones and Dr. "B", disappeared. Szilard's recounting of the events from 1963 to 1988 in "The Voice of the Dolphins" came from an impersonal third person voice that heightened the critical stance of Szilard's story because it was devoid of the possibility of personal delusion. There was no dream here, no narrative account dependent on the perspective of the individual. Future events were told plainly as future historical fact, and the fictional character of the story retreated into oblivion, just as the dolphins themselves did

in the story. The matter of fact voice of the future historian pronounced with the assurance of his vantage point, leading the reader through dystopia to a scientific utopia.

The narrative voice which dominated Szilard's fishy tale echoed the voice that dominated Wells's *The World Set Free*. It displayed, in the enlightened vision of a future historian, how the dolphins set the world free from the chains of the nuclear arms race. The dolphins used the power of science. The intellectual and technological innovations of science the dolphins produced transformed society and the world. The dolphins used their scientific voice to shape and guide political discussions. Using television to persuade the masses and manipulating politicians by playing on their unscrupulous ways, the dolphins orchestrated world events. The dolphins represented scientists who had been removed from the constraints of politics and ideology at the Viennese Institute. The scientists of the Viennese Institute, through "The Voice of the Dolphins," finally realized their power. They understood the problems that the nuclear age had brought to the world and knew that society had to be transformed, and they knew they had the power to do it.

"The Voice" of the dolphins gave expression to this power of science in the same way that the narrator of *The World Set Free* extolled the virtues of Marcus Karenin. "The

Voice" informed us of the vision of science and proclaimed scientists as arbiters of power, who understood the destructive and creative power of science. It spoke for the scientist as tragic hero, creator and destroyer of worlds, cognizant and unrepentant of his own power. It proclaimed "The Voice" of science as salvation, redeemer and savior of all humanity. "The Voice" of the dolphins illustrated, in this sense, the greatest fiction of Leo Szilard.

Notes

1. From a booklet explaining the purpose of a fictional TV program entitled *The Voice of the Dolphins* in Leo Szilard's short story "The Voice of the Dolphins" in Leo Szilard, The Voice of the Dolphins and Other Stories (New York: Simon and Schuster, 1961): 25-26.

2. In the recent biography of Szilard, William Lanouette says that, according to Leo Szilard's brother Bela, in his youth Szilard read H. G. Wells and Edward Bellamy. He also notes that Szilard used Bellamy's futuristic "technique" in his *Voice of the Dolphins*. My point here is to go beyond the anecdotal recognition of Szilard's interest in science fiction and explore the role of this rhetorical style in Szilard's understanding of science and the role of scientist in society. See William Lanouette with Bela Szilard, *Genius in the Shadows: A Biography of Leo Szilard, the Man Behind the Bomb*. (New York: Charles Scribner's Sons, 1992): 35.

3. Leo Szilard, "Recollections," 16-17.

4. Ibid., 16-17. For more on Otto Mandl and his conversations with Szilard, see William Lanouette with Bela Szilard, *Genius in the Shadows*, 96-97.

5. Leo Szilard, "Report on 'Grand Central Terminal,'" *The University of Chicago Round Table* (March 27, 1949), 575: 11-15.

6. Leo Szilard, "My Trial as a War Criminal," *The University of Chicago Law Review* (Autumn 1949), 17: 79-86.

7. Leo Szilard, *The Voice of the Dolphins and Other Stories* (New York: Simon and Schuster, 1961). Recently, this book was published in an expanded edition which included "The Mined Cities" and an introduction by Barton Bernstein. See *The Voice of the Dolphins and Other Stories*, expanded edition (Stanford, Ca.: Stanford University Press, 1992).

8. Leo Szilard, "The Diary of Dr. Davis," *Bulletin of the Atomic Scientists* (February, 1950), 6: 51-57.

9. Leo Szilard, "The Mined Cities," *Bulletin of the Atomic Scientists* (December, 1961), 17: 407-412.

10. Walter Knaus, "Die Stimme der Delphine: Eine Utopie nach Leo Szilards gleichnamiger Erzählung," Szilard Papers, MSS 32, Box 34, Folder 6. According to William Lanouette, this manuscript was written by Szilard. This hardly seems likely since it clearly has the author's name on it, and the title is as I have listed it above. See Lanouette *Genius in the Shadows,* endnote 50, p. 552.

11. Dr. Lily is actually mentioned in the story. See also William Lanouette with Bela Szilard, *Genius in the Shadows*, 415.

12. For more information on the publishing history of *Looking Backward* and the use of Bellamy's work as propaganda by the socialists and Marxist in the Hungary of the 1890's, see Sylvia Bowman, et al., *Edward Bellamy Abroad: An American Prophet's Influence* (New York: Twayne Publishers, 1962): 373-377.

13. Edward Bellamy, *Looking Backward: 2000-1887*, Riverside Press ed. (Boston and New York: Houghton Mifflin Co., 1926): 296.

14. Ibid., 326.

15. Ibid., 330-331.

16. For an interesting critique of Bellamy's use of historical knowledge, see William Casement, "On Not Looking Backward: The Role of Historical Knowledge in Bellamy's Utopia." *The Midwest Quarterly* 32, no.1 (Autumn 1990): 66-80. Casement argues that Bellamy and other utopian writers do not appreciate the value of history because they assign all that is in the past to the realm of evil and all that is in the future to the realm of good. This oversimplification of Bellamy's use of history does not appreciate the role played by history in utopian historical fiction in allowing for a critical stance toward the present. Bellamy employs a traditional narrative historical technique to the present

and the future. Far from depreciating the value of the idea that we can learn from a pre-utopian past, Bellamy's looking backward makes exactly that point by juxtaposing the present and the past historically, in Casement's terms, by presenting a narrative account of what happened in such a way as to judge what was good about the past and thus became a part of a utopian present, and what was bad, and thus did not survive the march of history to the present. In looking backward, the present is the future and the past is the present. In this regard, Bellamy was much more traditional than Casement would have us believe. History is the same for Bellamy as it is for Casement, the recounting of what was good and what was bad about the past, all with an eye for a better today.

For a longer and clearer exposition of this point see Jean Pfaelzer, "Immanence, Indeterminance, and the Utopian Pun in *Looking Backward*" in *Looking Backward, 1988-1888: Essays on Edward Bellamy*, edited by Daphne Patai, 51-67. (Amherst: The University of Massachusetts Press, 1988).

17. Bellamy's state was not a Marxist or communist state. He heavily criticizes the necessity of conflict in both as much as he criticizes the antagonistic competitiveness of capitalism. For a discussion of his critique and its relationship to Thorstein Veblen, see Rick Tilman, "The Utopian Vision of Edward Bellamy and Thorstein Veblen," *Journal of Economic Issues* 19, no. 4 (December 1985): 879-898.

18. On the point of transformation in Bellamy, see Lee Cullen Khanna, "The Text as Tactic: *Looking Backward* and the Power of the Word" in *Looking Backward, 1988-1888: Essays on Edward Bellamy*, edited by Daphne Patai (Amherst: The University of Massachusetts Press, 1988): 37-50.

19. Leo Szilard, "My Trial as a War Criminal" in *The Voice of the Dolphins and Other Stories*, 75.

20. Leo Szilard, "Report on 'Grand Central Terminal'" in *The Voice of the Dolphins and Other Stories*, 115.

21. Ibid., 122.

22. Leo Szilard, "Calling All Stars" in *The Voice of the Dolphins and Other Stories*, 105.

23. Ibid., 105-106, 109-111.

24. Leo Szilard, "The Mark Gable Foundation" in *The Voice of the Dolphins and Other Stories*, 90.

25. Ibid., 102.

26. Leo Szilard, "The Mined Cities," 407.

27. Ibid., 412. Indeed this temporary solution to the arms race had been suggested in "The Voice" as it had been in an earlier article on disarmament written by Szilard in the *Bulletin of the Atomic Scientists*. See Leo Szilard, "Disarmament and the Problem of Peace," *Bulletin of the Atomic Scientists*," 11 (October 1955): 297-307.

28. Ibid., 93.

29. Ibid., 104.

30. Leo Szilard, "The Diary of Dr. Davis," *Bulletin of the Atomic Scientists*, Vol. 6(Feb., 1950): 52.

31. Ibid., 52

32. Leo Szilard, "Recollections," 16.

33. H. G. Wells, *The World Set Free* (New York: E. P. Dutton and Co., 1914; London and Glasgow: Collins Clear Type Press, 1956): 43-44. All subsequent citations are to the 1956 edition. For a discussion of Well's debt to Frederick Soddy's *Interpretation of Radium*, see Lovat Dickson, *H.G. Wells: His Turbulent Life and Times* (New York: Atheneum, 1969): 228.

34. Ibid., 56.

35. Ibid., 103-104.

36. Ibid., 204.

37. Ibid., 208.

38. Ibid., 25.

39. Ibid., 53.

40. Ibid., 54.

41. Ibid., 117.

42. Ibid., 227.

43. Ibid., 234.

44. Ibid., 247-248.

45. I have used "men" here instead of "humanity" or some other more gender neutral term because it more accurately reflects the vision of Wells.

46. Szilard, *The Voice of the Dolphins and Other Stories*, 20. It should be noted that this story line followed Szilard's career change to biology in the post World War II period.

47. According to the story, the dolphins had to be coerced into communicating with the scientists by offering them "Sell's liver paste." It should be noted that Szilard loved liverwurst too. This is just one of many characteristics which Szilard shared with the dolphins.

48. Ibid., 43. All of this secret activity by the dolphins was revealed later in a book published in 1998 written by a former staff member of the institute who had retired to the Salk Institute in La Jolla, California. That was, of course, where Szilard retired.

49. Ibid., 71.

PART III
TRAGIC SCIENCE REVEALED

CHAPTER SIX
THE THERMODYNAMIC WORLD OF LEO SZILARD

The science of Leo Szilard literally had the fictive nature that he ascribed to it in his science fiction. Szilard's scientific concerns echoed the tragic situation of the scientist and the tragic power of science that he first encountered in Imre Madach's *The Tragedy of Man*. Science in Imre Madach's *The Tragedy of Man* unfolded through the dramatic actions and words of scientific characters. In a general sense, Madach's *Tragedy* emerged from Adam's confrontation with a determined nature. Madach intertwined Adam's attempts to understand nature with various conceptualizations of science by either portraying Adam as an idealistic scientist such as Kepler or forcing Adam to recognize the tragic power of the scientist as illustrated by The Scientist in the phalanstery scene who boldly stated the case for tragic science:

> Within four thousand years the sun will cool,
> And there will be no vegetation left
> On Earth. But those four thousand years are ours
> To seek a substitute for the sun-rays!
> That should be long enough, methinks, for Science.[1]

In either case, Madach linked the idea of science to the tragic, leaving Adam in the desolate world of the Eskimo as

determined and predicted by the second law of thermodynamics. In this final tragic situation, Adam had only the tragic admonition of man to guide him: "Strive on, Strive on, and Trust!" The juxtaposition of this admonition to the realization of the second law of thermodynamics in the final scene of *The Tragedy of Man* fully displayed a tragic vision that incorporated the laws of science.

Madach's and Szilard's tragic science always already existed--meaningfully--in the ambiguous realm of this juxtaposition. Szilard recalled it in his "Recollections" and described it in the political "science" of "*Der Bund*." After World War II, his understanding of tragic science reverberated in his comprehension of the role of science and scientists in a cold war world armed with nuclear weapons, and Szilard reiterated tragic science's original fictional quality in his science fiction. Szilard's science always already described, therefore, nothing less that this tragic comprehension of itself. In his science, Szilard literally comprehended a tragic world and inscribed the powerful metaphors of his tragic world in his papers on thermodynamics. In this chapter, the tragic nature of Szilard's thermodynamic world will be de-scribed as his papers on thermodynamics, completed in Berlin in the 1920s, are displayed.

Leo Szilard arrived in Berlin around the first of

January in 1920. At that time he wanted to continue his studies in electrical engineering at the *Technische Hochschule* in Berlin.[2] He had decided to study electrical engineering when he was in Budapest. His reasoning then as it seems to have been in Berlin was that "there was no career in physics."[3] This practical consideration kept him from committing himself to physics for about a year and a half.

Szilard claimed to have always had an interest in physics and that his choosing a different field of study was merely a question of economics, but he considered many options, including chemistry. In his "Recollections," he said that he thought about a career in chemistry while in Budapest: "I thought that if I studied chemistry I would learn something useful in physics and I would have enough time to pickup whatever physics I needed as I went along."[4] Also, according to Eugene Wigner, a fellow Hungarian and friend, Szilard had a "brief flirtation" with physical chemistry in Berlin before giving in to theoretical physics. In fact Szilard first met Wigner at the Institute for Physical Chemistry in Berlin.[5]

This flirtation, however, did not overcome Szilard's romantic encounter with physics. As Szilard put it, "Berlin at that time was in the heyday of physics." The Kaiser Wilhelm Institute in Dahlem had been established a few years earlier. Albert Einstein, Max Planck, Max Von Laue, and

others were there. Einstein's theories were front page news. The results of the studies of the March 29, 1919 eclipse, published in November of 1919, offered experimental proof of Einstein's Relativity Theory. Einstein was proclaimed the slayer of the Newtonian universe. A revolution was underway in physics, and Szilard recalled that "Finally the attraction became so big that I was physically unable to listen to any of the lectures through which I sat, more or less impatiently."[6]

Szilard enrolled at the University of Berlin to study physics in mid-1921. According to Wigner, as soon as Szilard decided to study physics "he introduced himself, with characteristic directness, to Albert Einstein," and persuaded Einstein to conduct a seminar in statistical mechanics at the university.[7] In this seminar Szilard became fully acquainted with the "new physics" of Albert Einstein and absorbed Einstein's approach and interest in thermodynamic fluctuations.[8]

Szilard's first published scientific work was in thermodynamics, begun when he was a doctoral student at the University of Berlin in 1921.[9] His final achievements in thermodynamics appeared in two articles in the *Zeitschrift für Physik*: "Über die Ausdehnung der phanomenologischen Thermodynamik auf die Schwankungserscheinungen"(1925) ("On the Extension of Phenomenological Thermodynamics to Fluctuation Phenomena") and "Über die Entropievermindung in

einem thermodynamischen System bei Eingriffen intelligenter Wesen"(1929) ("On the Decrease of Entropy in a Thermodynamic System by the Intervention of Intelligent Beings").[10] In his "Recollections," he explained these papers in the following way:

> Up to the time that I wrote this thesis [Szilard's dissertation] it was generally believed that the laws which govern the thermodynamical fluctuations must be derived from mechanics, and that they transcend what is called the second law of thermodynamics. I showed that the second law of thermodynamics was much more than just a plain statement about the average values; it also covers the laws which govern the thermodynamic fluctuations. This was not really a beginning, it was not the cornerstone of a new theory, it was rather the roof of an old theory.[11]

In forming his thermodynamic roof, Szilard described the second law of thermodynamics with respect to thermodynamic fluctuations. Starting in the latter decades of the nineteenth century, thermodynamic fluctuations were a part of an important and sometimes dramatic debate surrounding the certainty of the second law of thermodynamics, the reality of atoms and the meaning and purpose of science in the physics community. According to some scientists, these statistical anomalies in the second law of thermodynamics called into question the phenomenological certainty of physics. Statistical fluctuations in the second law of thermodynamics implied to scientists such as Ernst Mach that the second law of thermodynamics was not always true and that it might be violated in particular circumstances. If the second law of

thermodynamics was not certain in the sense that it could never be violated, as it appeared to be in all natural phenomena, then perhaps the kinetic theory of gases also was not true, and perhaps the mechanical model of the atom, on which kinetic theory rested, was not true either. In that case, atoms were just figments of the overly abstract scientific imagination and had no basis in phenomenological reality.

In tackling the fluctuation problem and attempting to put a "roof" on an old theory, Szilard signaled a deep concern for all of the above questions and dramatically displayed the scientific context of the second law of thermodynamics in the nineteenth century. More than simply displaying these problems, Szilard attempted to harmonize the nineteenth century phenomenological problem with the new statistical reality that had emerged in the late nineteenth and early twentieth centuries. The result was a powerful "tragic" comprehension of scientific knowledge continuously haunted by questions of phenomenological certainty and steadfastly certain of the powerful insights revealed by statistical knowledge.

The problems of nineteenth century phenomenological certainty first echoed in Szilard's call for an examination of "fluctuation phenomena," an anomaly of statistical thermodynamics, from a "purely phenomenological" perspective in "On the Extension":

> In a system in thermodynamic equilibrium, the parameters (e.g., the energy content of a subsystem) vary in time--they fluctuate. We want to show here that the second law [of thermodynamics] not only gives information about the mean value of these fluctuating parameters but also about the laws governing deviations from these mean values. Superficial considerations may give the impression that this is not possible, since the second law seems to fail just at the point where the fluctuations begin to be noticeable. This objection, however, is directed more toward the form rather than the basic ideas of thermodynamics. It is indeed possible to show that purely phenomenological thermodynamic considerations can lead to an understanding of those laws, the derivation of which is generally based on Boltzmann's principle.[12]

This "purely phenomenological" perspective on the second law of thermodynamics that Szilard recalled in these opening lines emerged in nineteenth century thermodynamics.

Sadi Carnot's theoretical study of the steam engine, *Reflections on the Motive Power of Fire* (1824), was the first instance of a statement relating to what later became known as the phenomenological second law of thermodynamics.[13] Carnot's concern with the efficiency of steam engines led him to postulate that the "motive power" of a steam engine was "due to its transportation from a warm body to a cold body, that is, to its re-establishment of equilibrium."[14] He further postulated that the difference in temperature of the hot and cold bodies was the sole determining factor for the motive power produced in a steam engine. The production of motive power did not depend on "the agent employed" to produce the temperature difference.

Since no one had ever encountered a perfectly efficient steam engine--one whose motive power was completely equal to its potential motive power as determined solely by temperature difference--Carnot had to explain why his theory did not fit practice.[15] Out of this explanation came the idea that in ordinary heat conduction- when two bodies of different temperatures were brought into contact and a transfer of heat took place--there was a loss of motive power in the steam engine. Therefore, there could not be a perfectly efficient steam engine. No engine operated without some form of heat conduction, and whenever heat was conducted, there was, according to Carnot, a natural loss in motive power.[16]

Carnot's conceptualization of the problems of heat left power in tact and shifted the metaphorical reality of phenomenological thermodynamics to conservation.[17] William Thomson first explicitly discussed the importance of conservation in Carnot's work.[18] Thomson embraced a dynamical theory of energy in which various forms of energy could be transformed one into the other with the overall effect of no loss in total energy.[19] This conservative idea encompassed not only all forms of energy but also the process by which energy was created or destroyed. Energy was not created or destroyed except by "Creative Power." This "Power" was the only exception to what Thomson, at the end of his 1852 paper, called "a universal tendency to the

dissipation of energy," Thomson's version of Carnot's theorem.[20]

Thomson's second law encompassed the tendencies of the material world and prescribed a relationship between the material world and a "Power" that controlled the material world. In other words, his second law was part of a natural philosophy that described a relationship between God--the source of this "Creative Power"--and nature. In Thomson's conception of the second law, Carnot's cycle became a "natural law," the universal dissipation of energy, that described the Creative Power of God.[21]

This metaphorical relationship in Thomson's understanding of the second law of thermodynamics linked the loss of "motive power" in Carnot's steam engine and the recognition of a unidirectional (in terms of time and energy) transformation of energy--the dissipation of mechanical energy.[22] Echoing Thomson's natural theology, the second law of thermodynamics became a universal law claiming absolute validity. It became a phenomena which represented the power of God in nature that could not be denied without disrupting the relationship between God and Man, a relationship that was directly observable in the phenomena of nature.

The power of Thomson's phenomenological understanding of the second law of thermodynamics was reiterated in the story of the development of the second law of thermodynamics

by the attention that W.J.M. Rankine and Rudolf Clausius gave to eliminating hypothetical realities in their descriptions of phenomenological thermodynamics. In developing his ideas on thermodynamics, Rankine used a complex vortex theory of matter different from the more prominent kinetic theory of heat. Described by one historian as an "alternative kinetic theory," Rankine's vortex theory envisaged roughly spherical propertyless pieces of matter in which internal motions--the interaction of the nucleus with its internal atmospheric fluid--and external motions--interactions with other vortical nuclear centers--produced pressure concentrations which were transmitted to the surrounding atmospheric fluid (aether). Using this vortex model of the atom, Rankine described a heat potential function -the so called "F function"--which defined a relationship between the heat potential of a system--internal energy--and the pressure, volume and temperature of a system, independent of the type of body in question. He then introduced this function into his mathematical description of the relationship between work and actual energy--external energy--in the vortical atomic system and derived a more general thermodynamic equation which mathematically reiterated Carnot's principle.[23]

Beginning in 1853, Rankine tried to remove all references to his vortex theory of matter from his expositions on thermodynamics, and attempted to come to a

more general understanding of the laws of thermodynamics without making reference to any hypothetical models.[24] He thought of the vortex theory as a psychological tool that he used to penetrate nature and his later results as inductive re-organizations, "without reference to any hypothesis as to the occult molecular operations with which the sensible phenomena may be conceived to be connected."[25] Comprehending his work in this way, Rankine moved away from the mechanistic nature of heat (no kinetic theory here) and toward an energetic comprehension of thermodynamics in which energy transformations were understood on the basis of a system of meta-laws inductively but abstractly derived from other laws alone--without reference to hypothetical models. This thermodynamic world conserved "entropy" in contra-distinction to Thomson's universal dissipation of energy and contained the possibility of a powerful renewal: "the world, as now created, may possibly be provided within itself with the means of reconcentrating its physical energies, and renewing its activity and life."[26]

Echoing Rankine's ambivalence to hypothetical mechanism's and reverberating Thomson's conservative description of the second law of thermodynamics as a phenomenological law only dependent on our observation of nature, Rudolf Clausius's work mathematically illustrated the powerful metaphors inscribed in the phenomenological understanding of the second law of thermodynamics. In his

early work of 1850 and 1854, Clausius delineated Carnot's cycle in terms of the sum of equivalence value transformations and restated the second law of thermodynamics. Each equivalent value transformation was equal to N such that for a reversible cycle,

$$N=\int \frac{dQ}{T}=0,$$

and in an irreversible cycle, N > 0.[27] In other words, "The algebraic sum of all transformations occurring in a cyclical process can only be positive."[28]

In his early work, Clausius insisted that this law was applicable without taking into account the internal processes of the substances involved. However, up until 1865, when Clausius bluntly proclaimed, "The energy of the universe is constant. The entropy of the universe tends to a maximum," he continuously examined the idea that heat was motion.[29] In 1857 and 1858, he published significant work on the kinetic theory of gases. He defined in mechanical terms the nature of the motions of molecules in a gas in terms of rectilinear and rotary motions and described the mean free path of gas molecules.[30] These considerations led Clausius to relate his thermodynamic principles to both internal and external molecular motions. In 1862, Clausius defined the relationship between heat and work in terms of the relationship between molecules: "the effect of heat always

tends to loosen the connection between the molecules, and so to increase their mean distances from one another."[31] He then introduced the concept of "disgregation," a mathematical function meant to describe "the degree in which the molecules of the body are dispersed."[32] Using this disgregation principle, Clausius then redefined the first and second law of thermodynamics such that the second law of thermodynamics became:

$$dS = \frac{dH}{T} + dZ,$$

where H is the heat in a body, T is the temperature, and Z is the disgregation. This molecular comprehension of thermodynamic phenomena clearly depended on the idea of an "innere Arbeit" in thermodynamic systems as measured by disgregation.

In the sense that Clausius's work proceeded from this molecular understanding, he mathematically inscribed a haunting hypothetical reality into his phenomenological second law of thermodynamics and his all encompassing concept of "entropy": "a magnitude which represents the sum of all the transformations which must have taken place in order to bring any body or system of bodies into its present condition."[33] Clausius's "entropy" conserved the phenomenological power of the second law of thermodynamics, but mathematically described the second law of

thermodynamics by referring to a hypothetical mechanical system. In so doing, Clausius displayed the metaphorical reality of the phenomenological second law of thermodynamics in great mathematical detail, and entropy became the mathematical metaphorical reality that described the nature of power and the power of a "purely phenomenological" understanding of nature. At the same time, because Clausius's concept of entropy derived from a hypothetical mechanical molecular description of nature, Clausius's entropy concept constantly recalled non-observable entities whose reality threatened to disrupt the phenomenological nature that Clausius's concept of entropy claimed to describe in such mathematical detail.

Szilard's consideration of the second law in "On the Extension" recalled Clausius's mathematical representation of a Carnot cycle:

> First we have to sharpen the second law giving special consideration to the fluctuations. The point of departure for this is a well-known formulation of this classical postulate of thermodynamics. We consider a closed, isolated system consisting of:
> a) a system of different bodies that undergo cyclic processes;
> b) a weight that can be moved up and down and which serves as energy reservoir;
> c) a number of infinitely large heat reservoirs, called support reservoirs, which serve for the absorption of the heat released in the cyclic processes.
>
> The classical postulate then says: In a cyclic process in which the heat contents of all but one

> support reservoir remain the same, the heat content of this particular reservoir cannot decrease.[34]

This phenomenological understanding of the second law, his mathematical presentation of a "purely phenomenological" explanation, served as a constant reference in his evaluation of fluctuation phenomena. Szilard stated that all thermodynamic considerations were to be brought into harmony with this phenomenological understanding of the second law of thermodynamics. In particular, statistical fluctuations were to be understood on the basis of "purely phenomenological considerations." This was not an idle reference. It was the *raison d'être* of Szilard's paper. Szilard sought to incorporate thermodynamic fluctuations into the phenomena of thermodynamics and, thereby, to restore the metaphorical harmony implied by such a phenomenological understanding, a harmony which conserved the comprehensive power of a phenomenological thermodynamic world.

Szilard's restoration process began with a formal exposition of the phenomenological second law. He then incorporated fluctuation phenomena into phenomenological reality by redefining those phenomena in classical terms. Szilard represented fluctuation phenomena in terms of the phenomenological second law: In a cyclic process, "which undergoes the same cycle repeatedly," the quantity of heat absorbed by any heat reservoir in an isolated system on any

given cycle (Q_i) fluctuated. That is, "we will find a different value for Q_i every time."[35] These fluctuations were then brought into the classical postulate of the second law by introducing a "statistic" for the value of Q_i which was "a matter of chance in each individual process."[36] Szilard footnoted this statement by saying "The claim that some probability law applies is an assumption on which this work is based."[37] By making this assumption Szilard introduced a notion of statistical trials into the phenomenological second law ($W_i(Q)dQ$), but he did not abandon his phenomenological approach. He prescribed, instead, a statistical approach to the phenomenological reality of the second law of thermodynamics.

But the phenomena had changed now. Szilard no longer described the phenomenological second law by showing that it was true for each trial or for each case. He described it by assuming it was a law that was phenomenologically correct for an average of all trials in a thermodynamic cycle:[38]

$$\overline{Q}=\int_{\infty}^{\infty} Q W_i(Q)\, dQ=0$$

This statistical "postulate," therefore, represented his conviction that "exploitation of the fluctuation phenomena will not lead to the construction of a perpetuum mobile of the second kind."[39] Szilard then proceeded from this

statistical representation of a phenomenological conviction to a redefinition of the phenomenological second law in statistical terms, transforming the classical statement that the entropy (S) of a cyclic system must be greater than or equal to zero, into a statistical postulate that said that the average entropy of an infinite number of cyclical systems will be greater than or equal to 0.[40] Szilard used the following analogy to make his point clear:

> Consider somebody playing a thermodynamic gamble with the help of cyclic processes and with the intention of decreasing the entropy of the heat reservoirs. Nature will deal with him like a well established casino, in which it is possible to make an occasional win but for which no system exists ensuring the gambler a profit.[41]

The phenomenological reality of this statistical phenomenon was clear for Szilard and his analysis of fluctuation phenomena proceeded from it.

This phenomenological approach, while recalling the conservative power of the metaphors inherent in a phenomenological understanding of the second law of thermodynamics, also reiterated the daunting problem of this approach that had haunted the work of Rankine and Clausius. Szilard's attempt to harmonize thermodynamic fluctuation and the phenomenological second law of thermodynamics introduced an ambiguity into his conception of the second law of thermodynamics best illustrated by his understanding of a thermodynamic statistic. Szilard said that "if we consider instead of one body undergoing many cycles, many identical

bodies undergoing the cycle at the same time. We shall call it again a 'cyclic process' just as long as the statistic is the same before and after the process."[42] This definition of a "statistic" equated the process of many trials on one thermodynamic system with many different, but identical systems undergoing the same cycle. Statistically Szilard considered them the same and, therefore, the "postulate of thermodynamics holds for both cases."[43]

Within a phenomenological perspective, this identity created a problem. Since fluctuations were a phenomena, by definition and description, they were a phenomenological reality which had to be allowed in individual thermodynamic cycles. In an individual cycle, therefore, the second law of thermodynamics could be violated. But at the macroscopic level, the level of infinite cycles or infinite similar cycles, the second law could not be violated. By embracing the phenomenological reality of thermodynamic fluctuations and insisting on comprehending these phenomena within the phenomenological understanding of the second law of thermodynamics, Szilard divided the phenomenological world in two and displayed the hypothetical world of the atom that had been muted and submerged in the work of Rankine and Clausius. In that world, the phenomenological truth of the second law of thermodynamics remained ambiguous.

Szilard chafed under this uncertainty throughout "On the Extension." Metaphorically, he wanted the "pure" order

of the phenomenological world and wanted to comprehend all of thermodynamic reality within that world, including statistical fluctuations, and he relegated the demon of his phenomenological world to a footnote, where he confided:

> It is plausible to express an apprehension against the present form of the second law, which originates from Maxwell:
>
> If we had some demon at our disposal who could accurately guess the instantaneous values of the parameters and take the appropriate action, then it would certainly be possible to construct a perpetuum mobile of the second kind, if this demon were willing to help. We humans cannot guess these parameters, but we can measure them and could take appropriate action. This raises the question whether we do not arrive in this way at a contradiction with the exact form of the second law.[44]

This footnote referred to one of the earliest and most persistent criticisms of the phenomenological second law of thermodynamics by James Clerk Maxwell.

In a letter to the English physicist P.G. Tait (1867), Maxwell first introduced a thought experiment in which he postulated an intelligent being who could deal with thermodynamic systems on a molecular level in such a way that the phenomenological second law of thermodynamics would be violated. Dubbed Maxwell's demon by Lord Kelvin, this intelligent being was made public in 1871 in Maxwell's *Theory of Heat*:

> Now conceive of a finite being who knows the paths and velocities of all the molecules by simple inspection but who can do no work except open and close a hole in the diaphragm by means of a slide without mass.[45]

Maxwell's thought experiment started with the fundamental assumptions of the kinetic theory of gases. Accordingly, he defined temperature in terms of the kinetic energy distribution in a volume of gas. Defined in this manner, a higher temperature implied a higher average kinetic energy. At the individual molecular level, this meant that the kinetic energy of some individual molecules could be higher or lower than the average kinetic energy. Maxwell's demon was capable of observing individual molecules and determining their kinetic energy. Maxwell placed this demon at a diaphragm opening between two volumes of an ideal gas, A and B, with volume A containing a gas with a higher average kinetic energy than B (A has a higher temperature than B). This finite being only opened the diaphragm for a molecule in A "when that molecule had a velocity less than the root mean square velocity of the molecules in B." Alternately, he opened the diaphragm for a molecule in B "when its velocity exceeded the root mean square velocity of the molecules in A."[46] In this way the demon made the average kinetic energy of A higher and the average kinetic energy of B lower. In Maxwell's words, "the energy in A is increased and that in B diminished; that is, the hot system has gotten hotter and cold colder and yet no work has been done, only the intelligence of a very observant and neat-fingered being has been employed."[47]

Maxwell's demon represented the ambiguities of his

conceptualization of heat as a statistical distribution that he first explicated in his paper "Illustrations of the Dynamical Theory of Gases" (1860).[48] In this paper, Maxwell transformed the "law of errors," a law which signified the statistical uncertainty associated with human observations, into a mathematical description of the kinetic theory of gases that comprehended thermodynamic systems in terms of dynamic interactions in particulate systems.[49] In so doing, he defined a new relationship between a mathematical distribution and a thermodynamic system. The mathematical distribution that Maxwell defined now represented the physical reality of a gaseous dynamical system. This new statistical reality portrayed the heat of a thermodynamic system as a distribution of the velocities of the particles contained in that system and the temperature as an expression of the mean kinetic energy of the particles in the system.

While distinguishing the statistical character of thermodynamic systems, Maxwell characterized thermodynamic systems in uncertain terms. The representation of a thermodynamic system in terms of a velocity distribution described a physical reality that was statistically certain, and certainty depended on the greater knowledge obtained by being able to comprehend the collective actions of a system of particles. Maxwell, nevertheless, differentiated this statistical certainty from historical or dynamic certainty

which he related to knowledge of individual particles in a thermodynamic system. Only the latter knowledge demonstrated absolute certainty.[50]

In making this distinction, Maxwell inverted the traditional notion of statistics that comprehended statistics and the law of errors as yielding a greater certainty than the dynamical method because it described a broader range of phenomena and incorporated individual tendencies in a predictable mathematical fashion. Maxwell described this massive information as a poverty of knowledge, displaying not so much how much was known but the limits on what can be known.[51] What could not be known, according to Maxwell, was the behavior of individual particles. All of the laws of the kinetic theory only related to statistical systems and yielded no knowledge of the behavior of individual particles. The laws of thermodynamic systems, especially the second law of thermodynamics, were, therefore, only statistical laws that offered only statistical certainty.

It was precisely this point that Maxwell's demon made. The ability of the demon to contradict the second law of thermodynamics depended on its ability to have knowledge of the motions of the individual molecules, and it was only through this infinite perception that the second law of thermodynamics could be violated. This did not tarnish the second law of thermodynamics, however, if one understood, as

Maxwell did, that the second law of thermodynamics was merely a symbolic representation of what we (human beings) perceived, and what we perceived was only the statistical behavior of a collection of molecules.[52] The second law of thermodynamics, as represented by Maxwell, therefore, described the physical reality that could be known--aggregate reality--and from this aggregate reality one could not have any absolutely certain information about the dynamic behavior of individual molecules. The behavior of an individual molecule could not be predicted with absolute certainty. For Maxwell, this uncertainty was as much an inherent part of the second law of thermodynamics as its predictive value with relation to aggregate thermodynamic systems.

This inherent uncertainty in Maxwell's statistical representation of the second law displayed a certain advantage nevertheless. The reality of Maxwell's statistical world--collectively organized but not determined by the second law--embraced the organizing principle of the second law and allowed for an inherent uncertainty--free will--in the order defined by entropy. Maxwell's *deus ex machina*--his know-it-all demon--guaranteed this duality and signified the certainty of ambiguity in a world governed by the "statistical" second law of thermodynamics.

The uncertainty guaranteed by Maxwell's spiritual demon

haunted all of Szilard's work in thermodynamics. In his second paper on thermodynamics, "On the Decrease," he came back to this demon, but in "On the Extension," the wavering image of Maxwell's demon appeared every time he iterated "fluctuation phenomena." Szilard focused on displaying the harmony of the phenomenological second law and the statistical reality he had inherited from James Clerk Maxwell, Ludwig Boltzmann and Albert Einstein. He first defined energy fluctuations by equating the statistical distribution of the energy content of one body with "the energy statistic of a series of an infinite number of samples of the same body." This latter distribution he called "the normal distribution at temperature T."[53] Then he interpreted this statistical distribution as a phenomenological reality: "If the series is given by its normal distribution . . . We will find in this case it is impossible to change the energy statistic, keeping the mean energy fixed, without compensation."[54] Szilard then devoted the next section to the "Determination of the Equilibrium Statistic" whose phenomenological existence was a given: "In the present section, however, we shall assume its existence and determine the laws which the stable distribution must necessarily obey."[55] He then determined the "Equilibrium Statistic to be:[56]

$$W_2^*(u,T) = C(T)\, g(u)\, e^{\varphi(T)u}.$$

This equilibrium function was a continuous function, and Szilard made it clear that he was not interested in considering the "possibility that specific energy values . . . have a finite probability (quantized energy distribution) . . . we want to limit ourselves here to the continuous distribution so as not to complicate matters."[57]

In the next section, Szilard presented a symmetrical representation of the second law of thermodynamics by describing the phenomenological reality of the second law of thermodynamics in terms of "energy statistics" in his presentation of an approximate calculation of "The Deviation from the Normal Distribution." He obtained a universal function of temperature that displayed a deviation from the normal distribution in relation to mean energy content:[58]

$$\frac{n^*}{\frac{d\bar{u}^*}{dT}} = \psi(T) .$$

Reiterating his phenomenological comprehension of this statistical representation of a deviation from the normal distribution, Szilard concluded: "It is remarkable that the existence of such a universal function follows already from the phenomenological second law."[59] He had statistically represented the phenomenological second law, and not surprisingly, he derived an expression for a statistical

deviation from a normal distribution in that representation of the phenomenological second law.

His statistical understanding of thermodynamic phenomena in the next sections followed directly from his statistical representation of the phenomenological second law of thermodynamics, and he displayed the phenomena of thermodynamics statistically. He described "'Free' and 'Normal' Adiabatic Processes" and "'Normal' Cyclic Processes." He did this by representing adiabatic processes statistically and relegated the phenomenological problem of fixing the volume of a gas in a statistical thermodynamic system to a remark at the end of the paper.[60] In that remark, he reiterated Ludwig Boltzmann's symmetrical conceptualization of the equipartition of space, which considered phenomenologically fixed space to be the same as the division of statistical space into small finite areas. That is, Szilard considered a phenomenologically exact volume of gas to be the same as the statistical representation of a space interval that fluctuated within a very small volume interval Δv. By equating these two conceptions of space, one can consider, as Szilard did, "an infinite number" of bodies whose states were determined by their volume and energy as if one was considering only one body. This equality incorporated the statistical fluctuations of volume and energy, and statistical uncertainty diminished to the very small finite spaces that

were only perceptible at the molecular level. The phenomenological uncertainty of the second law of thermodynamics at the molecular level had again appeared, this time in the spatial details--remark six--of Szilard's phenomenological comprehension of statistical reality. Despite his attempt at harmonizing phenomenological and statistical reality, Szilard's thermodynamic world remained divided between the phenomenological macroscopic world and the uncertain statistical microscopic world.

Ludwig Boltzmann had been the first to work out the devilish details of this phenomenological comprehension of the statistical second law of thermodynamics in the latter half of the nineteenth century. In conversations and letters exchanged in the *Wiener Berichte* with Josef Loschmidt, Boltzmann was forced to realize certain problems with his mechanical "proof" of the second law of thermodynamics in 1872. Loschmidt had voiced serious misgivings to Boltzmann about the "heat death" implied by the second law of thermodynamics, and he wanted to "destroy the terroristic nimbus of the second law, which has made it appear to be an annihilating principle for all living beings of the universe; and at the same time open up the comforting prospect that mankind is not dependent on mineral coal or the sun for transforming heat into work, but rather may have available forever an inexhaustible supply of transformable heat."[61] He addressed this set of problems associated with

the second law of thermodynamics by emphasizing the theoretical possibility of reversibility in all mechanically described systems. One could mechanically describe an isolated system that changed from some initial state at a particular time (t = 0) to a different state that was more mixed (in the diffusion of a gas, for example) or more uniform (in terms of its temperature distribution, for example, i.e., mixing gases at different temperatures). This description showed that there was an entropy increase. It was possible, however, because we were describing the system mechanically--meaning the equations were symmetrical with respect to the direction of time--to conceive of simply reversing the direction of this process (simply reversing the collisions and velocities of the gas molecules). In that case, there would be a decrease in entropy and the second law of thermodynamics would be violated.

Loschmidt's objection forced Boltzmann to recognize the statistical nature of his representation of the second law, and, in his "Further Studies" paper of 1872, he conceptualized the second law of thermodynamics in terms of improbability tantamount to impossibility rather than phenomenological impossibility. He granted that Loschmidt had discovered an instance of entropy decrease, but this instance also uncovered, according to Boltzmann, the probabilistic nature of the second law of thermodynamics. According to the theory of probability no molecular

distribution may be excluded from possibility, even if it was extremely improbable.

Such a representation of the second law of thermodynamics comprehended the reality of probability and the probability of reality. That is, reality was not indeterminate for Boltzmann. He described reality in terms of probability and determined that reality in terms of probability. It was a reality that prescribed the possibility of a new nature based on the phenomena of statistical fluctuations with respect to time, but Boltzmann did not see that possibility.[62] By labeling statistical fluctuations as improbability tantamount to impossibility, he had tried to do away with the phenomenological reality of thermodynamic fluctuations and still perceived of them as a contradiction to the reality of phenomenological thermodynamics.

Szilard's statistical representation of thermodynamic phenomena in "On the Extension" was clearly informed by an understanding of the significance of Boltzmann's statistical fluctuations. He began his reiteration of Boltzmann by symmetrically reproducing the phenomenological understanding of entropy in statistical terms. Szilard's description of adiabatic processes and normal cyclic processes showed this most clearly. He concluded his presentation in the following way:[63]

> If the value of the mean energy runs through a closed curve, then we have for the participating

reservoirs[15]

$$\bar{S}=0.$$

This means that for a body, fully determined by volume and energy content,

$$d\bar{S}=-\frac{\bar{p}^{*}dv+d\bar{u}^{*}}{T}$$

is a complete differential, which yields the relation

$$\bar{p}^{*}+\frac{\partial\bar{u}^{*}}{\partial v}=T\frac{\partial\bar{p}^{*}}{\partial T}$$

Here

$$\bar{p}^{*}(T)=\int_{0}^{\infty}p(u)\,W^{*}(u,T)\,du,$$

so that along the normal adiabatic expansion, according to equation (15), we have

$$d\bar{u}=-\bar{p}^{*}dv.$$

[15] Remember analogous considerations in classical thermodynamics. There we had for all reversible cyclic processes

$$S=O.$$

This leads to the result, that

$$dS=-\frac{pdv+du}{T}$$

is a complete differential. From this we obtain the relation

$$p+\frac{\partial u}{\partial v}=T\frac{\partial p}{\partial T}$$

where p is the pressure and, along the adiabate, we have for the work done

$$du=-pdv.$$

From this symmetrical representation of the second law, Szilard then deduced Boltzmann's constant from his statistical representations of the second law of thermodynamics and adiabatic and cyclical thermodynamic

phenomena.[64] In the final section, he introduced the statistical representation of an adiabatic thermodynamic system into his phenomenological consideration of the entropy change in an adiabatic system.[65] From this statistical representation of the entropy of an adiabatic system, Szilard derived a version of Boltzmann's statement of the second law of thermodynamics:[66]

$$S=k\int_0^{\infty} W\log\frac{G}{W}du. \quad (30)$$

Szilard's representation of Boltzmann's second law of thermodynamics was not a simple reiteration. It displayed statistical thermodynamics with a clear understanding of the difference between phenomenological and statistical thermodynamics and sought a reconciliation between the two in a particular way, by focusing on "fluctuation phenomena." Thermodynamic fluctuations were always already phenomena for Szilard, not just statistically unlikely aberrations in nature as they had been for Boltzmann. Szilard embraced the idea of "fluctuation phenomena" and extended the phenomenological comprehension of thermodynamic phenomena to include statistical fluctuations, hoping to validate the phenomenological reality of statistical fluctuations and statistical reality by recalling the powerful metaphors of the phenomenological understanding of a thermodynamic world.

He wanted to show that the statistical second law of thermodynamics echoed the conservative, certain nature metaphorically inscribed in a phenomenological understanding of the second law of thermodynamics. That was why he ended his paper with a description that emphasized the harmony that he perceived himself to have created between a phenomenological understanding of the world and statistical fluctuations:

> We wanted to show that the second law does not lose anything of its exact character even in view of fluctuations and does not deteriorate to an approximate law but evolves in some higher harmony thus determining the laws of fluctuations as well.[67]

Many scientists in the nineteenth century had criticized any attempt to harmonize the phenomenological and statistical second laws in this way. Ernst Mach criticized the statistical second laws dependence on mechanistic molecular models (kinetic theory). Others like Henri Poincaré and Ernest Zermelo criticized its inconsistency with respect to the absoluteness of the phenomenological statement of the second law of thermodynamics and saw in its phenomenological inconsistency a reason to look for a higher phenomenological reality in energetics theory.[68] Other scientists nevertheless began to look into the possibilities of this new reality and realized the significance of Boltzmann's statistical representation of the second law of thermodynamics. Planck explored the combinatorial approach of Boltzmann and its assumptions about the discreetness of

energy in a thermodynamic system. In addition, Einstein, in his early work, explored the physical meaning of the statistical approach to thermodynamics by comprehending statistical fluctuation as a phenomena of nature, an approach that Szilard partially recalled in "On the Extension."

Einstein first realized the significance of "fluctuation phenomena" in a 1904 paper on thermodynamic fluctuations.[69] Einstein understood that uniquely within the statistical description of the second law of thermodynamics, there existed the possibility of thermodynamic fluctuations--small, temporary deviations from the second law of thermodynamics, or, more accurately, small local spikes in Boltzmann's H curve. Whereas Boltzmann had sought to eliminate the possibility of such energy fluctuations in order to maintain the connection between his statistical description of the second law of thermodynamics and mechanistic reality, in his 1904 paper, Einstein described these temporary fluctuations in a thermodynamic system as a phenomena of nature.[70] He interpreted Boltzmann's statistical statement of entropy ($S = \kappa \log W$) as describing the phenomena of thermal equilibrium and determined that the constant κ represented the thermal stability of a system in the sense that κ described the scale of the internal energy fluctuations of a system in thermal equilibrium, according to the equation,

$$\langle \Delta^2 \rangle = \langle (E - \langle E \rangle)^2 \rangle = \kappa T^2 \frac{d\langle E \rangle}{dT},$$

where $\langle \Delta^2 \rangle$ is the mean square fluctuation, E is the internal energy of a system, $\langle E \rangle$ is the average value of the energy of a system, and $\kappa = R/N_o$ (the gas constant over Avogadro's number for the number of molecules in a gram molecule of a gas).[71] Described in this phenomenological manner, thermodynamic fluctuations were metaphorically free of statistical uncertainty because they were now a phenomena of nature that determined the reality of the thermodynamic world. Einstein now intellectually lived in a free thermodynamic world of statistical reality, unfettered from the metaphorical necessities of the mechanistic world view.

Armed with his phenomenology of statistical thermodynamics, Einstein soon discerned the possibilities of these fluctuations as a phenomenon of nature. He published a paper in 1905 entitled "On the Movement of Small Particles Suspended in a Stationary Liquid Demanded by the Molecular-Kinetic Theory." [72] This paper formulated the mean displacement of suspended particles and described "A New Method of Determining the Real Size of the Atom." In so doing, Einstein portrayed Boltzmann's statistical fluctuations as a phenomena of nature, Brownian motion.

In a second paper on Brownian motion, published in 1906, he extended his argument to even more phenomena and

included an explication of rotational motion as well as displacement along one axis in his description of Brownian motion. In this presentation, Einstein made explicit in no uncertain terms his commitment to the statistical description of thermodynamics as phenomenological principle:

> This relation [between probability and the parameters of a system], which corresponds exactly with the exponential law frequently used by Boltzmann in his investigations in the theory of gases, is characteristic of the molecular theory of heat. It explains how far a parameter of a system, when a constant external force is applied, can diverge from the value which corresponds to stable equilibrium, as a result of irregular molecular movements.[73]

This statement represented one of the first statements of "Boltzmann's Principle," in which the statistical understanding of thermodynamics was perceived as a phenomenological reality. This new reality emerged from Einstein's skepticism of mechanical representations of reality--Einstein's first critique of the kinetic theory as being to model specific--and replaced the causal certainty of that mechanistic reality with a statistical representation that assumed more probable states would always follow improbable ones. In this replacement, Einstein transformed statistical mechanics, filled with questions of uncertainty, into a phenomenological certainty--determined by the principle of the second law of thermodynamics as expressed by Boltzmann--from which all of reality was simply a matter of deduction.[74] Einstein's work always already displayed this belief in the phenomenological nature of the

thermodynamic world, and he was certain that the determined nature of his thermodynamic world was conserved in his statistical representations of thermodynamics.

> It [the second law of thermodynamics] is the only physical theory of universal content concerning which I am convinced that within the framework of the applicability of its basic concepts, it will never be overthrown (for the special attention of those who are skeptics on principle).[75]

In "On the Extension," Szilard reverberated the exact and determined metaphorical nature of Einstein's statistical thermodynamics. Szilard's formulation of the second law recalled the "higher harmony" of Einstein's thermodynamic world already at peace with the phenomenological reality of statistical thermodynamics.[76] Einstein's description of Brownian motion as the macroscopic manifestation of the statistical understanding of the second law of thermodynamics provided Szilard with a phenomenological perspective on thermodynamic fluctuations. Thus, he always referred to them as "fluctuation phenomena." At the same time, because Szilard started his examination of fluctuation phenomena with the "classical" postulate of the second law of thermodynamics instead of the statistical definition of Boltzmann, as Einstein did, Szilard's understanding of fluctuation phenomena also always recalled the powerful conservative metaphors presented in the story of the phenomenological second law of thermodynamics. In other words, Szilard had the difficulty of having to "extend" phenomenological thermodynamics to incorporate statistical

fluctuations into the metaphors of phenomenological reality, and thermodynamic fluctuations had to be justified on the basis of "purely phenomenological thermodynamic considerations."[77] This had to be done, according to Szilard, so that "the second law does not lose anything of its exact character even in view of fluctuations and does not deteriorate to an approximate law."[78]

Szilard, therefore, did not begin with Boltzmann's principle, as Einstein did. Instead he followed the somewhat uneconomical path of representing phenomenological thermodynamics statistically. For Szilard, both phenomenological and statistical thermodynamics echoed in his signification "fluctuation phenomena," and the necessity of this higher harmony resonated throughout the paper as Szilard sought to mute the noisy clash of phenomenological reality, steeped in the traditions of mechanism and causal certainty, and an emerging statistical reality, strongly espousing its own non-mechanical, aggregate order.

Szilard's commitment to this harmonious phenomenological comprehension of the second law was inscribed with a tragic character, despite its acceptance of a statistical nature. He was tragically determined to reconcile the determined nature inscribed in the phenomenological second law of thermodynamics with the real but always phenomenologically uncertain nature of the

statistical second law of thermodynamics as represented by "fluctuation phenomena." For Szilard, this scientific quest, muted and submerged in the predominately statistical reality of quantum physics in the early 1920s, was science, and it was a science which recalled the tragic science of Imre Madach. Its focus on the second law of thermodynamics and its understanding of the necessity of a phenomenological comprehension of the second law echoed *The Tragedy of Man*. In his quest for knowledge, Madach's Adam continuously confronted a future determined by the second law of thermodynamics. This law as determined by science forced Adam to confront the tragic nature of the task of science when he conversed with The Scientist in the phalanstery scene. The Scientist outlined the nature of tragic science in these words:

> Within four thousand years the sun will cool,
> And there will be no vegetation left
> On Earth. But those four thousand years are ours,
> To seek a substitute for the sun-rays!
> That should be long enough, methinks, for Science.[79]

In the final desolate Eskimo scene, a future world determined by the second law of thermodynamics, Adam came to understand the tragic nature of the thermodynamic world and the tragic struggle in which he was engaged trough the admonition of God to "Strive On!" Adam and The Scientist lived in this tragic thermodynamic world determined by the second law of thermodynamics. They could not avoid it. The future of the thermodynamic world was determined. They could

not help but seek knowledge about their world and hope to escape their unavoidable future. That was their tragic task.

Szilard mentally lived in this tragic world and proclaimed his tragic task in "On the Extension." He tackled the second law of thermodynamics as phenomenological reality. He did not try to escape or submerge his tragically determined nature in an uncertain statistical reality. Instead, he focused on reconciling the statistical reality of thermodynamic fluctuations with his phenomenological reality. He embraced the tragic truth of the second law and inscribed the dramatic power of the tragic vision of the second law into his science by incorporating thermodynamic fluctuations into a deterministic vision of nature and science. "On the Extension" extended his tragic vision of a thermodynamic world determined by the phenomenological second law into the statistical reality described by "fluctuation phenomena." In so doing, Szilard tragically comprehended the world in thermodynamic terms possessed by the demonic visions of Madach's *The Tragedy of Man*.

In his second paper on thermodynamics, "On the Decrease of Entropy in a Thermodynamic System by the Intervention of Intelligent Beings," Szilard confronted the demons of his thermodynamic world:

> There is an objection, already historical, against the universal validity of the Second Law of Thermodynamics, which indeed looks rather ominous. The objection is embodied in the notion of

> Maxwell's Demon, who in different ways appears even nowadays again and again; perhaps not unreasonably, inasmuch as behind the precisely formulated question quantitative connections seem to be hidden which to date have not been clarified.[80]

He now considered the greatest challenge to his harmonic formulation of the second law of thermodynamics, Maxwell's Demon. This fiendish concept was a serious problem that undermined Szilard's signification of thermodynamics in "fluctuation phenomena" because it presented the logical possibility that the phenomenological reality of thermodynamic fluctuations allowed for the theoretical possibility of violating the phenomenological second law of thermodynamics. It is one thing to incorporate "fluctuation phenomena" into the phenomenological understanding of the second law of thermodynamics as Szilard does in "On the Extension." It was quite another to say, as Maxwell's demon did, that if you comprehend statistical fluctuations within the second law of thermodynamics, then these very phenomena inherently undermine the second law of thermodynamics as a phenomenon of nature. The very signification "fluctuation phenomena" admitted statistical exceptions to the second law of thermodynamics and these exceptions transformed the second law of thermodynamics into something less than a phenomenological certainty. This characterization of the problem, encapsulated in Maxwell's Demon, challenged Szilard's thermodynamic world by pointing out the logical difficulties with his signification of statistical

fluctuations as "fluctuation phenomena," and recalled the satanic visions of Madach's tragic science by questioning science's *raison d'être*. Szilard's thermodynamic world lived with these devilish problems that constantly kept the scientific control of nature in tragic flux.

In "On the Decrease," Szilard envisaged a way to control the demons of his thermodynamic world by recasting the role of Maxwell's demon. Szilard admitted that the second law of thermodynamics could be violated if an "experimenting man" could make use of "fluctuation phenomena." That is, one could make use of information that one had about a particular thermodynamic system and manipulate the system in such a way as to violate the second law of thermodynamics. This "experimenting man" would be:

> a sort of *deus ex machina* . . . who is continuously and exactly informed of the existing state of nature and who is able to start or interrupt the macroscopic course of nature at any moment without the expenditure of work.[81]

This representation of the problem recognized the power of Maxwell's demon and sought to capture its power by characterizing two aspects of the demon. On the one hand, Maxwell's demon represented a "biological phenomena" in the sense that the demon made use of information in an intelligent way. By using this information, the demon, as a biological phenomena, temporarily contradicted the second law of thermodynamics. In another sense, however, Maxwell's demon was not a "biological phenomenon" because it did not

exhibit the biological characteristics of having a sensory and nervous system in which "a degradation of energy is always involved, quite apart from the fact that the very existence of a nervous system is dependent on continual dissipation of energy."[82] Szilard's demon now had a dual personality that conceded that as a *deus ex machina* Maxwell's demon could not be refuted, but as a "biological phenomenon" in the second sense above, the power of the demon could be refuted because living beings always dissipate energy. In other words, if the devil ever really came to life, he would die too.

Going beyond this, Szilard particularly addressed the nature of the demon's biological intelligence, as the complete title of the paper suggested, "On the Decrease of Entropy in a Thermodynamic System by the Intervention of Intelligent Beings." Szilard associated the mind of the demon with intelligence by displaying the demon as a "nonliving" mechanical device determined by the second law of thermodynamics. He imagined a simple machine that coupled together information about particular molecules in a thermodynamic system and the entire thermodynamic system in such a way that the system violated the second law of thermodynamics, mechanically repeating the devilish activities of the demon. The information that Szilard coupled together was a parameter (x) of a molecule that fluctuated between the interval (x_1, x_2) in a movable piston

system, and the position y (-1,1) of a lever that indicated the interval within which a molecule existed at particular time. The movable piston system had two fixed pistons and two movable pistons. Within the system, two of the piston heads were impermeable and two were semipermeable. When the intelligent being intervened, he recorded the interval within which a particular molecule fell and assigned it a value of y = 1 or y =-1, depending on which interval (x_1, x_2) the molecule fell. This lever was then connected to a mechanical system which manipulated the movable system in such a way that molecules within one interval passed through one semi-permeable membrane and those in the other interval passed through the other semi-permeable membrane. In this way, by separating the two different types of molecules, Szilard's mechanical device violated the second law because the volume of the container expanded without doing work by using information about the individual molecules. This mechanical demonic system, therefore, had a negative entropy.

Szilard, however, aimed at calculating the entropy of his demon and not just the negative entropy of the demonic system. As he said:

> If we do not wish to admit the Second Law has been violated, we must conclude *that the intervention which establishes the coupling between y and x, the measurement of x and y, must be accompanied by a production of entropy.*[83]

Szilard, therefore, calculated the entropy of his coupling

device, noting the necessary increase in total entropy for a small decrease in entropy within the larger thermodynamic system. In other words, Szilard calculated the increase in entropy necessary to operate the nonliving device and showed that this increase compensated for the negative entropy obtained in separating the various particles in the system. The demons information, it seemed, as represented by the coupling of two independent but interactive variables, had a certain entropy associated with it. When this entropy was considered, the entropy of the system remained O or increased. From these considerations Szilard concluded: "We have examined the 'biological phenomena' of a nonliving device and have seen that it generates exactly that quantity of entropy which is required by thermodynamics."[84] The Second Law of Thermodynamics had been saved from Maxwell's demon.

Szilard's exorcism of his demon again displayed his phenomenological representation of the statistical second law and fully described his tragic embrace of a thermodynamic world determined by the second law of thermodynamics. Szilard's mechanical characterization of "biological phenomena" represented all aspects of life as thermodynamic phenomena. Sensory and nervous systems, even intelligence, became thermodynamic phenomena in a thermodynamic world. In that world, Maxwell's demon always had a certain legitimacy and haunted true understanding of

the world. In this sense, Maxwell's demon controlled Szilard's visions of the thermodynamic world, like Satan controlled the visions of Adam in *The Tragedy of Man*. At the same time, Szilard had to deny and attempt to control the demon of the thermodynamic world by controlling Maxwell's demon. Szilard had to incorporate his demons biological capacities into the realm of thermodynamics ruled by the second law of thermodynamics and control him by discovering the secret of the demons ability, a thermodynamic relationship between temporary decreases in entropy (later called negentropy) and information.[85] Out of this discovery emerged the possibility of temporary local reversals of the second law of thermodynamics, and irreversible nature now became temporarily reversible through scientific thermodynamic information. Szilard now realized the vision and authority of science in his "tragic science." In a thermodynamic world, nature was determined by the second law of thermodynamics, and this knowledge allowed the scientists to describe, manipulate and control nature, including all "biological phenomena." Szilard had now inscribed into his science the tragic words of The Scientist:

> Within four thousand years the sun will cool,
> And there will be no vegetation left
> On Earth. But those four thousand years are ours
> To seek a substitute for the sun-rays!
> That should be long enough, methinks, for Science.[86]

At peace with his demon and cognizant of the power of his tragic vision of science, Szilard now did as the Lord in

Madach's Tragedy had bade him to do. He strove on in his tragic quest to find the transformative power of his thermodynamic world though which he could transform himself and the world:

> It suddenly occurred to me that if we could find an element which is split by neutrons and which would emit two neutrons when it absorbed one neutron, such an element, if assembled in sufficiently large mass, could sustain a nuclear chain reaction . . . . In certain circumstances it might become possible to set up a nuclear chain reaction, liberate energy on an industrial scale, and construct atomic bombs. The thought that this might be in fact possible became a sort of obsession with me.[87]

Notes

1. The Scientist in Imre Madach's *The Tragedy of Man*, 251.

2. After some difficulty, Szilard was admitted to the *Technische Hochschule*. He described the attitude in Berlin toward foreign students as "not friendly," and he had "to bring to bear all the pressure I could through such private connections as I was able to muster in the city of Berlin." Szilard, "Recollections," 8.

3. Ibid., 5.

4. Ibid.

5. Eugene P. Wigner, "Leo Szilard" in the National Academy of Sciences, *Biographical Memoirs*, 40(New York: Columbia Univ. Press, 1969): 338.

6. Szilard, "Recollections," 8,9.

7. Wigner, "Leo Szilard," 338.

8. Ibid.

9. Szilard, *"Recollections*," 9,11. Szilard completed his dissertation, *Über die thermodynamischen Schwankungserscheinungen*, on this topic in 1922. In this chapter I have chosen deliberately to remain focused on analyzing his two published works because they represent the most complete and rigorous version of his thought on

thermodynamics. "Szilard" must be analyzed without attempting to reduce "Szilard" to his earliest, defined as more original, work. This is a tendency in the history of science which I would like to formally resist.

10. Leo Szilard, "Über die Ausdehnung der phanomenologischen Thermodynamik auf die Schwankungserscheinungen," *Zeitschrift fur Physik*, 32 (1925): 753-788. I will be using the translation of this work as it appears in the first volume of Szilard's published papers *The Collected Works of Leo Szilard: Scientific Papers*, eds. Bernard T. Feld and Gertrude Weiss Szilard (Cambridge, Mass.: The M.I.T. Press, 1972): 70-102, hereafter cited as "On the Extension"; Leo Szilard, "Über die Entropievermindung in einem thermodynamischen System bei Eingriffen intelligenter Wesen" *Zeitschrift für Physik*, 1929, 53, 840-856. I will be using the translation as it appears in the first volume of the published papers *The Collected Works of Leo Szilard: Scientific Papers*, eds. Bernard T. Feld and Gertrude Weiss Szilard (Cambridge, Mass.: The M.I.T. Press, 1972): 120-129, which comes from a translation by Anatol Rapoport and Mechthilde Knoller in *Behavioral Science*, 9:4 (October, 1964): 301-310m, hereafter cited as "On the Decrease." Szilard states in his "Recollections" that this paper was begun when he was a doctoral student in 1921-22.

11. Szilard, "Recollections," 11.

12. Szilard, "On the Extension," 70.

13. For detailed example of the early development of the second law of thermodynamics, see Stephen Brush, *The Kind of Motion We Call Heat: A History of the Kinetic Theory of Gases in the 19th Century*, 2 Vols. (Amsterdam: North Holland, 1976): 566-589. Carnot's *Reflections on the Motive Power of Science* is the text most often cited.

14. Carnot as quoted by Brush in *Heat*, 567. For further references to the significance of Carnot and the second law of thermodynamics see Keith Hutchinson's "W.J.M. Rankine and the Rise of Thermodynamics," *British Journal of the History of Science* 14(1981): 1.

15. Carnot assumed that heat was conserved, contradicting what would later be implied by the conservation of energy. I will not be discussing the development of this law, the first law of thermodynamics. It is assumed in every discussion of thermodynamics in the last quarter of the nineteenth century, and since my purpose here is the explication of the phenomenological second law, I will limit my discussion of the first law to what is necessary for the explication of the phenomenological versus statistical second law.

16. In mathematical terms, we would say that in a reversible Carnot cycle the work done is equal to the heat absorbed by the system: W = Q. In a carnot cycle going from a state of

$$Q_2(p_2, V_2, T_2)$$

to a state

$$Q_1(p_1, V_1, T_1)$$

the work done, assuming the conservation of energy, is defined by

$$W=Q_2-Q_1$$

and the efficiency of the cycle is

$$E=\frac{W}{Q_2}=\frac{Q_2-Q_1}{Q_2}=1-\frac{Q_1}{Q_2}.$$

17. In Carnot's cycle it was still not clear how one could talk of the conservation of heat (caloric) and a natural loss of some sort of (motive) power. There is an interesting discussion of Carnot's cycle in Brush, *We Call Heat*, 546-47, and 567-569. There is a sense in which Brush and others seem absolutely fascinated by the fact that the Second Law of Thermodynamics precedes the First Law of Thermodynamics. It seems to Brush and others an unnatural scientific birth-logically incomprehensible. I think this is only because they see in Carnot a bastardized form of the second law and do not realize the significance of the carnot cycle for representing a context in which conservation and loss must be worked out. In this sense the two laws are not discovered separately but always already meaningfully present in the ambiguity of conservation and loss as I have described. Herein lies the significance of Carnot's cycle. In other words, how can the cyclical functions of state (p,V,T) also be unidirectional and linear with respect to time, that is, irreversible.

18. Please note that I have not begun my discussion of the systematization of the second law of thermodynamics with William Thomson because I believe that he is the first to systematically present the second law. The debate over this priority was heated throughout the 1860's and 70's as the work of Peter Daub shows. (Peter Daub, "Entropy and Dissipation," *Historical Studies in the Physical Sciences* 2 (1970): 321-354) I am not interested in explicating this debate. I am more interested in explicating what is known historiographically as the systematization of classical thermodynamics: "What was emerging by the early 1850's, then, was classical thermodynamics as a science based on two axioms or laws, and independent of hypothetical or un-

observable entities. The development of this science conceptually, mathematically and experimentally constituted one of the most important and far-reaching phases of nineteenth century physics." Crosbie W. Smith, "William Thomson and the Creation of Thermodynamics: 1840-1850," *Archive for the History of the Exact Sciences* 16 (1976-77): 231-288.

19. For an account of Thomson's gradual acceptance of this dynamical concept of conservation see Crosbie W. Smith, "William Thomson and the Creation of Thermodynamics: 1840-1855." The work of Smith, Brush and Daub all strongly suggest the interpretation that I am offering here, and I owe a great deal to their work as well.

20. The full citation is: "The object of the present communication is to call attention to the remarkable consequences that follow from Carnot's proposition, that there is an absolute waste of mechanical energy available to man when heat is allowed to pass from one body to another at a lower temperature, by any means not fulfilling his criterion of a "perfect thermo-dynamic engine," established, on a new foundation, in the dynamical theory of heat. As it is certain that Creative Power alone can either call into existence or annihilate mechanical energy, the "waste" referred to cannot be annihilation, but must be some transformation of energy." Thomson as quoted by Brush in *Heat*, 572. This comes from Thomson's paper of April 19, 1852 and is part of a series of papers Thomson published on his dynamical theory of heat between 1851 and 1855. This particular statement is what is usually referred to by Brush, Crosbie Smith, Peter Daub and others as the "Kelvin statement" of the second law of thermodynamics.

21. For a more extensive study of Thomson's "natural philosophy" see Crosbie Smith, "Natural Philosophy and Thermodynamics: William Thomson and 'the Dynamical Theory of Heat.'" *British Journal of the History of Science* 9 (1976).

22. I have not used the word irreversible here because I do not think that it is appropriate to do so with regard to Thomson. This is primarily due to the theological context of his work. Although in the strict sense of a Carnot cycle it might be justified, with regard to the entropy of a Carnot cycle it is not. In the 1850's, Thomson did not introduce a concept of entropy. He talked about dissipation. "Entropy" first appeared in the work of Rudolf Clausius.

23. $$F=\int \frac{1}{T}\cdot\frac{dQ'}{dV}\cdot dV=\int \frac{dP}{dT}\cdot dV,$$

$$\int_{V_0}^{V_1} PdV_A-\int_{V_0}^{V_1} PdV_B=\int_{F_0}^{F_1} FTdF_A-\int_{F_0}^{F_1} TdF_B=\int_{V_0}^{V_1} (T_A-T_B)/T_A\cdot\frac{dQ'_A}{dV}\cdot dV.$$

Edward E. Daub, "Atomism and Thermodynamics." *Isis* 58 (1967): 300.

24. Keith Hutchison, "W.J.M. Rankine and the Rise of Thermodynamics," 11.

25. W.J.M. Rankine as quoted by Keith Hutchison in "W.J.M. Rankine and the Rise of Thermodynamics," 14.

26. W.J.M. Rankine as quoted by Stephen G. Brush from "On the Reconcentration of the Mechanical Energy of the Universe," *Philosophical Magazine* 4 (1852): 358. See Stephen G. Brush, *Heat*: 573-74 and Keith Hutchison, "W.J.M. Rankine and the Rise of Thermodynamics," 16. See footnote 86 in particular for Hutchison's view that Rankine did not feel "the force of the conventional second law."

27. The value of a particular transformation depended on the temperature of the two bodies. For a more complete mathematical description of Clausius's reasoning, see Brush, *Heat*, 574-576.

28. Ibid., 576.

29. Rudolf Clausius, *Mechanical Theory of Heat*: 327; originally appeared in German as: "*Die Energie der Welt ist constant; die Entropie der Welt strebt einem Maximum zu*" in Rudolf Clausius, "Über verschiedene für die Anwendung bequeme Formen der Hauptgleichungen der mechanischen Wärmetheorie," *Annalen der Physik*, 125 (1865): 353-400.

30. Rudolf Clausius, "The Nature of the Motion Which We Call Heat," and "On the Mean Lengths of the Paths Described by the Separate Molecules of Gaseous Bodies," translations as they appear in Stephen G. Brush, *Kinetic Theory*, Vol. 1 (Oxford: Pergamon Press, 1965): 111-147.

31. Rudolf Clausius as quoted by Martin J. Klein, "Gibbs on Clausius," *Historical Studies in the Physical Sciences*, Vol. 1 (1969): 136, from Rudolf Clausius, *The Mechanical Theory of Heat*, 220.

32. Ibid.

33. Rudolf Clausius as quoted by Martin J. Klein in "Gibbs on Clausius," *Historical Studies in the Physical Sciences*, Vol. 1 (1969): 140, from Rudolf Clausius, "On the Second Fundamental Theorem of the Mechanical Theory of Heat," *Philosophical Magazine* 35 (1868): 419.

34. Szilard, "On the Extension," *70*.

35. Ibid., 70.

36. Ibid.

37. Ibid., 71.

38. Ibid.

39. Ibid.

40. $S \geq 0 \rightarrow \overline{S} \geq 0$.

41. Szilard, "On the Extension," 73.

42. Ibid., 71.

43. Ibid.

44. Ibid., footnote 3, 73.

45. Martin J. Klein quoting Maxwell in a letter to P.G. Tait, December 11, 1867 in "Maxwell, His Demon, and the Second Law of Thermodynamics," *American Scientist* 58(Jan.-Feb., 1970): 86. A copy of the original letter can be found in C.G. Knott, *Life and Scientific Work of Peter Guthrie Tait* (Cambridge, 1911): 213-214.

46. Ibid.

47. Ibid.

48. James Clerk Maxwell, "Illustrations of the Dynamical Theory of Gases," *Philosophical Magazine* Vol.19 (1860) as reprinted in Stephen G. Brush, *Kinetic Theory*. Vol. 1: 148. In this paper, Maxwell illustrated how the velocities of a system of elastic particles "are distributed among the particles according to the same law as the errors are distributed among the observations in the theory of the 'method of least squares'."Ibid., 154. In so doing, Maxwell introduced the statistical theory of Adolphe Quételet and

John Herschel into the kinetic theory of gases. Theodore M. Porter, "A Statistical Survey of Gases: Maxwell's Social Physics." *Historical Studies in the Physical Sciences* 12 (1981): 77-116.

49. The "law of errors" is mathematically represented by

$(1/\sqrt{\pi})\exp(-x^2)$.

50. P.M. Heimann, "Molecular Forces, Statistical Representation and Maxwell's Demon." *Studies in the History and Philosophy of Science* 1 (1970): 199-201. This, of course, is not a logically necessary distinction and is not one which most statisticians of the early nineteenth century made. See Porter, "A Statistical Survey of Gases" for a discussion of this.

51. P.M. Harmann in *Metaphysics and Natural Philosophy: The Problem of Substance in Classical Physics* (Sussex and New Jersey: The Harvester Press and Barnes and Noble Books, 1982): 147-148, argues that this division is part of Maxwell's field oriented natural philosophy which resolves the question of substance by defining "matter qua substratum" as unknowable while "the method of dynamical explanation provides the basis for a physical interpretation of a symbolic representation, based on the disjunction between dynamical (functional) and substantial representations of matter." In this sense, Maxwell's velocity distribution was a symbolic representation of a thermodynamic system consisting of collection of bits of matter that can only be dynamically represented and in and of themselves are unknowable.

52. "The idea of dissipation of energy depends on the extent of our knowledge. Available energy is energy which we can direct into any desired channel. Dissipated energy is energy which we cannot lay hold of and direct at pleasure, such as the energy of the confused agitations of molecules which we call heat. Now confusion, like the correlative term order, is not a property of material things in themselves, but only in relation to the mind which perceives them." Maxwell as quoted by Porter, "A Statistical Survey of Gases," 102.

53. Szilard, "On the Extension," 74.

54. Ibid.

55. Ibid.

56. Ibid., 76.

57. Ibid., 77.

58. Ibid., 79.

59. Ibid., 79.

60. "6)Speaking exactly, we are not allowed to start from an exact volume but should start from a state in which the piston can move freely a finite if very small interval. Because we should not that by acting on the piston with a constant force which balances the pressure on the average, the free piston will not remain at rest but will perform a sort of Brownian motion, and its position will fluctuate about the equilibrium position . . . However, we can fix once and for all a small interval representing a volume Δ inside of which the piston can move freely up and down." Ibid., 93.

61. Josef Loschmidt as quoted by Brush, *Heat*, 605, original German in footnote 28, 614; from Loschmidt, *Wiener Berichte* 73, 128, 366 (1976): 139.

62. My thoughts here coincide with many on the dual nature of Boltzmann's representation of probability, especially Martin J. Klein's. See Klein, "The Development of Boltzmann's Statistical Ideas," 88 for a description of this duality in his work in the 1890's; see Theodore M. Porter, "A Statistical Survey of Gases: Maxwell's Social Physics." *Historical Studies in the Physical Sciences* 12 (1981): 77-116, for a discussion of the mechanical world view remnants in his probability theory; see Brush, *Heat*, 608-612 for absolute puzzlement over this inconsistency; see Wladyslaw Krajewski, "The Idea of Statistical Law in Nineteenth Century Science" in *Boston Studies in the Philosophy of Science*, Vol. 14: *Methodological and Historical Essays in the Natural and Social Sciences*, ed. R.S. Cohen and M.W. Wartofsky. (Dordrecht/Boston: D. Reidel, 1974): 397-405 for a brief but insightful discussion of statistical representation in the nineteenth century.

63. Szilard, "On the Extension," 82.

64. Ibid., 83-85.

65. Ibid., 87-89.

66. Ibid., 89.

67. Ibid., 89-90.

68. Critics of the second law of thermodynamics such as the French mathematician Henri Poincaré attacked the statistical definition of the second law by using the recurrence

theorem. This theorem emphasized that all mechanical systems are cyclic in nature so that closed systems will eventually return to their initial configuration. Applying this theorem to molecular thermodynamic systems, Poincaré concluded that in order to see the second law of thermodynamics violated, "it will not be necessary to have the acute vision, the intelligence, and the dexterity of Maxwell's demon; it will suffice to have a little patience." Brush quoting Poincaré, in *Kinetic Theory*, Vol. 1, 206.

The physicist Ernst Zermelo accepted this so-called "Recurrence Paradox" as proof that the mechanistic view, as represented by kinetic theory, contradicted experience and thus had no meaning. Zermelo and others (including Ernst Mach) assumed that the second law must be absolute and not statistical and therefore rejected the notion implied by Boltzmann's definition that deviations from the second law could occur although they were unlikely. Poincaré's proof of the Recurrence Paradox which purported to show the inevitable contradiction of the second law of thermodynamics seemed to them to put into question the validity of all mechanistic models, atomic models included.

For a description of problems with atomism and the energetics school of thought in the late nineteenth century, see Peter Clark "Atomism versus Thermodynamics," *Method and Appraisal in the Physical Sciences: The Critical Background to Modern Science, 1800-1905*, ed. Colin Howson. (Cambridge: Cambridge University Press, 1976): 41-105; Edward E. Daub, "Atomism and Thermodynamics," *Isis* 58 (1967): 293-303; Erwin Hiebert "The Energetics Controversy and the New Thermodynamics," *Perspectives in the History of Science and Technology*, Duane H.D. Roller (Norman: University of Oklahoma Press, 1972): 67-97.

69. Albert Einstein, "On the General Molecular Theory of Heat," in *The Collected Papers of Albert Einstein*, Vol. 2. Trans. Anna Beck, Consultant Peter Havas. (Princeton, N.J.: Princeton University Press, 1989): 68-77; from "*Zur allgemeinen molekularen Theorie der Wärme*," *Annalen der Physik* 14 (1904).

70. Boltzmann, while conceding the logical possibility, repeatedly tried to show that they were a practical impossibility, and therefore a phenomenological improbability. See Boltzmann's reply to Zermelo's criticism. For example, "Reply to Zermelo's Remarks on the Theory of Heat" trans. Stephen G. Brush, *Kinetic Theory* Vol. 2: 218-228; from "*Entgegnung auf die wärmetheoretischen Betrachtungen des Hrn. E. Zermelo*," *Annalen der Physik* 57 (1896): 773-84.

71. Klein, "Thermodynamics in Einstein's Thought," 511.

72. Einstein put his examination in perspective in the following way: "In this paper it will be shown that according to the molecular-kinetic theory of heat, bodies of microscopically-visible size suspended in a liquid will perform movements of such magnitude that they can be easily observed in a microscope, on account of the molecular motions of heat." (Albert Einstein, "On the Movement of Small Particles Suspended in a Stationary Liquid Demanded by the Molecular-Kinetic Theory." in Investigations on the Theory of the Brownian Movement, ed. by R. Furth and trans. by A. D. Cowper (London: Methuan and Co., Ltd., 1926): 1; originally published as "*Die on der molekularkinetischen Theorie der Wärme gefordete Bewegung on in ruhenden Flüssigkeiten suspendierten Teilchen*," *Annalen der Physik* 17 (1905).) Einstein's examination of particles suspended in a liquid began in principle with the statistical explication of the second law of thermodynamics and extended the applicability of that law to visible phenomena by recognizing the relationship between thermodynamic fluctuations, uniquely implied by the statistical approach to thermodynamics, and the diffusion of particles suspended in a liquid. He described a diffusion process "which is to be looked upon as a result of the irregular movement of particles produced by thermal molecular movement," and determines the distribution of the displacement of a particle due to thermal fluctuations (in only one coordinate direction in this paper). Quotation on page 11.

73. Albert Einstein, "On the Theory of the Brownian Movement" in *Investigations on the Theory of the Brownian Movement*, ed. by R. Furth and trans. by A. D. Cowper (London: Methuan and Co., Ltd., 1926): 19-35. Citation is on page 23. Originally published as "*Zur Theorie der Brownschen Bewegung*," *Annalen der Physik*, 19 (1906): 371-381.

74. The French physical chemist Jean Perrin completed an exhaustive experimental study using Einstein's insight a few years later. Einstein realized the importance of Perrin's work almost immediately. Mary Jo Nye has written in her study on the work of Perrin that: "Einstein, as well as Perrin, fully appreciated the extraordinary effect which an experimental proof relating a phenomenon such as Brownian movement to the kinetic-molecular theory would have in securing the complete acceptance of that theory and in dumb-founding its critics." See Mary Jo Nye, *Molecular Reality: A Perspective on the Scientific Work of Jean Perrin* (New York: American Elsevier Publishing Co., 1972): 113.

75. Albert Einstein, "Autobiographical Notes," in *Albert Einstein: Philosopher Scientist*, 2nd. ed., ed. by Paul A. Schilpp (New York: Tudor Publishing Co., 1951): 33.

76. Anecdotal evidence supports this important connection as well. Szilard began his studies in thermodynamics in a seminar held by Einstein, and Szilard makes reference to Einstein's work on thermodynamics at the very end of "On the Extension" where he says, "it seems more reasonable to us to follow a path indicated by Einstein, if we want to obtain the statistical laws of thermodynamics." Szilard, "On the Extension," 89.

The "other" path that Szilard is referring to here is a little unclear. That is largely because Szilard's footnote to Einstein seems to be in error. Both the German and English versions of "On the Extension" refer to Einstein "(*Verh. d. Deutsch. Phys. Ges.* 12, 820, 1914)." Such a paper does not seem to exist. There is a paper by Einstein entitled "*Beitrage zur Quantentheorie*," *Verh. d. Deutsch. Phys. Ges.* 16, 820, 1914. If this is the paper referred to by Szilard, then it indicates that Szilard was interested in Einstein's concern with deriving thermodynamics using phenomenological considerations. The opening of Einstein's paper illustrates this: *In what follows, two considerations are rendered which, in so far as they belong together, show how far the most important new results of thermodynamics, namely Planck's radiation forms and Nernst's theorem, can be derived, without the help of Boltzmann's principle, by pure thermodynamic means with the use of the fundamental ideas of quantum theory. [Im nachfolgenden sind zwei Betrachnungen wiedergegeben, die insofern zusammengehören, als sie zeigen, inwieweit die wichtigsten neueren Ergebnisse der Wärmelehre, nämlich die Planckische Strahlungsformal und das Nernstsche Theorem ohne Zuhilfenahme des Boltzmannschen Prinzips auf rein thermodynamischen Wege mit Benutzung des Grundgedankens der Quantentheorie abgeleitet werden können.*]

77. Szilard, "on the Extension," 70, 89.

78. See footnote 69.

79. Imre Madach, *The Tragedy of Man*, 251.

80. Szilard, "On the Decrease," 120.

81. Ibid., 121.

82. Ibid., 121.

83. Ibid., 125.

84. Ibid., 128. This exorcism of Maxwell's Demon is in some sense unsatisfactory because it admits that the Second Law of Thermodynamics can temporarily be violated, although it maintains the law for all aspects of the system in time. Szilard's characterization, however, does introduce the

problem that an intelligent being might intervene in the nonliving mechanical device in order to violate the second law of thermodynamics. If we substitute a mechanical device for that "megademon," then perhaps the second law will be maintained. Unless, of course, we introduce a "megamegademon." One can see how Szilard's mechanical representation of the intelligent being can lead to an infinite production of demons. Szilard's thermodynamic world, it seems, is full of demons.

For a vehement attack on Szilard's exorcism of Maxwell's Demon based on this circularity, see Karl R. Popper "Irreversibility; or, Entropy since 1905." *British Journal of the Philosophy of Science*, 8 (1957): 151-155.

85. For an interesting examination of Szilard's re-discovery by Leo Brillouin and others in information theory in the 1950's, see Katherine N. Hayles, "Self-Reflective Metaphors in Maxwell's Demon and Shannon's Choice," *Literature and Science: Theory and Practice*, Stuart Peterfreund, ed. (Boston: Northeastern University Press, 1990): 209-237. Hayle says of Brillouin interpretation of the demon and his use of Szilard's paper in information theory: "Brillouin expanded . . . his interpretation [of Maxwell's Demon] by later emphasizing that information theory completely eliminates the "human element." The threshold was passed; the Demon no longer functioned as liminal figure mediating between human limitations and inhuman entropy. The dream behind the Demon was realized in another sense, however, for the potent new force of information had entered the arena to combat entropy." pg. 220.

It would seem to me that Szilard's "On the Decrease" led in this direction. Control, not denial, seemed to be Szilard's aim, an aim which conceptualized the role of science in a particularly powerful way by allowing scientists the ability to combat entropy through a thermodynamic understanding of information.

86. The Scientist in Madach's *The Tragedy of Man*, 251.

87. Szilard, "Recollections," 17.

CHAPTER SEVEN
THE NUCLEAR VISION OF LEO SZILARD

The transformative nature of Leo Szilard's thermodynamic world emerged most clearly in Szilard's comprehension of nuclear science. Szilard's conception of science, grounded in thermodynamic principles capable of comprehending "biological phenomena," described a powerful intellectual tool that could, in principle, transform the world and escape the demons that haunted the phenomenological world. Science, in Szilard's thermodynamic comprehension of it, became an arcanum.

Szilard's science fiction portrayed scientists as having arcane power, by virtue of their ability to comprehend the nature of things through scientific principles, to prescribe scientific solutions to world problems. That kind of power could be horrible--transforming society into a conglomeration of toothless figures at the mercy of plates that chew their food; or laudable--wisely guiding the world toward world peace. In either case, it had the tragic power of creative transmutation, and the scientist constantly struggled to control a scientific vision that was often warped and deformed by the unenlightened forces of society. Sometimes he succeeded. Sometimes he did not, but he was forever locked in this

tragic struggle, often appalled by what he saw but unable to deny it, always seeking to know more but unable to control it. Szilard's "discovery" of a nuclear chain reaction displayed this visionary character of science and scientists transmuting the world through their intuitive knowledge. As Szilard himself stated in a 1964 interview:

> The creative scientist . . . has much in common with the artist and the poet. Logical thinking and an analytical ability are necessary attributes to a scientist, but . . . they are far from sufficient for creative work. Those insights in science which have led to a breakthrough were not logically derived from pre-existing knowledge; the creative processes on which the progress of science is based operate on the level of the subconscious.[1]

If we are to gain insight into the metaphorical nature of Szilard's "discovery" of transmutation, Leo Szilard's often quoted epiphany about the nuclear chain reaction should be understood with this vision of science in mind:

> As I was waiting for the light to change and as the light changed to green and I crossed the street, it suddenly occurred to me that if we could find an element which is split by neutrons and which would emit two neutrons when it absorbed one neutron, such an element, if assembled in sufficiently large mass, could sustain a nuclear chain reaction. I didn't see at the moment just how one would go about finding such an element, or what experiments would be needed, but the idea never left me. In certain circumstances it might become possible to set up a nuclear chain reaction, liberate energy on an industrial scale, and construct atomic bombs. The thought that this might be in fact possible became a sort of obsession with me.[2]

Szilard's story of his discovery displayed the transmutational character of his science in two ways.

Szilard's personal "Recollections" delineated a personal transformation in which Szilard became a creative visionary of nuclear science. Converging with the personal story, Szilard's scientific work in nuclear science described the nature and power of transmutation. These stories together signified Szilard's comprehension of transmutation as the arcanum of the thermodynamic world.

Szilard's realization of the significance of transmutation did not emerge immediately from his work in thermodynamics. Both Szilard's "Recollections" and his scientific papers tell of the creative struggle that Szilard faced after completing his studies on thermodynamics. He simply did not have a clear idea of what to do next. According to his friend and colleague Eugene Wigner, Szilard "felt that his skill in mathematical operations could not compete with that of his colleagues."[3] Szilard never mentioned this insecurity or recounted much of his activities in Berlin from 1923 to 1930 in his "Recollections," but his scientific papers seem to confirm Wigner's conclusion that because of Szilard's perception of his weakness in mathematics, he moved away from theoretical physics. Instead of continuing his studies in thermodynamics or taking up another problem, as Wigner tells us, "he spent most of his time experimenting with X-rays in collaboration with H.[Hermann] Mark, and pursuing some of his engineering

ideas."[4]

The two papers that he published during this period, in June and November of 1925, dealt with X-ray crystallography and were done in conjunction with Hermann Mark, an experimental physicist working at the Kaiser Wilhelm Institute (KWI) at the time.[5] These two papers involved a refinement of information about X-rays and their use in crystallography and were a part of a larger series of studies carried out by Mark's group studying X-rays at the institute. In recalling this period of his work, Mark described how X-rays became an important diagnostic tool in solid state research, and how "the key role of X-rays and gamma rays for basic problems concerning the structure of radiation and matter . . . focused attention on general questions of the physics of X-rays and electrons."[6] The importance of the latter questions inspired a systematic study of X-rays, according to Mark, and he noted that "under the influence and with the active cooperation of Einstein, Kallman, Von Laue, Szilard, and Wigner studies . . . were carried out in a series of articles."[7]

Szilard's contributions to the papers written with H. Mark were more inspirational than experimentally substantial. A. L. Patterson, an American experimental physicist who came to Berlin in 1924, portrayed the dynamics of Mark's group in the following way:

Mark's group at the Kaiser-Wilhelm Institute für

> Faserstoffchemie involved Bredig, Ehrenberg, Gottfried, Herrlinger, Kratky, Naray-Szabo, von Susich, Weissenberg, *with Szilard and Kallman in sort of orbital attachment.*[8]

In addition, in a recent interview with Mark done by William Lanouette, Mark said that Szilard was not too concerned with the details of experimental x-ray crystallography. Instead Szilard suggested that the focus of study should be on the X-rays themselves and constantly offered ideas for further study in this direction, but he did not carry out the experimental work himself. Indeed, he became known, affectionately for the most part, as the *Generaldirektor.*[9]

This persona of Szilard as the restless creative scientist directing the search for more fundamental truths was an important characterization in Szilard's story of the discovery of nuclear transmutation. Part of this creative persona was Szilard's ability to see not only the scientific importance of his work but to recognize the possible industrial, social and political applications of his science. Szilard's science, in this sense, always already went beyond the normal bounds of scientific activity. Szilard, therefore, did not limit his scientific energy to the laboratories of the KWI. From 1923 to 1925 Szilard filed a total of six patents. He and Imre Patai, an old friend from Budapest, designed an "X-ray Sensitive Cell" and filed for a patent on October 9, 1923. Four other patents followed in 1924 and 1925, all of which were designs for an electron

discharge tube.[10] One of these patents was a design for an electron discharge tube filed jointly with the German company Siemans on September 2, 1925.

In 1926 Szilard began working on a "Method for Pouring Metals into Molds Through the Use of Electric Currents" that he patented on January 20, 1926.[11] This patent was part of his ongoing work with Einstein aimed at building a household refrigerator "without any moving parts."[12] A practical application of their knowledge of thermodynamics and electromagnetic theory, Szilard and Einstein thought that their self-contained liquid metal pump design, with no gaskets or seals, could avoid the possibility of toxic chemical leakage in a refrigeration system.[13] As might be expected from two theoretical physicists, however, the refrigerator turned out to be "not very practical," as Szilard put it.[14] Szilard and Einstein were never able to reduce the noise level of their design.[15]

All of these patents and many others that followed in the 1930s displayed Szilard's creative comprehension of the science in which he was involved. The x-ray patents came out of the work he was doing with Mark. The refrigeration work materialized from his discussions with Einstein on thermodynamics and electromagnetic theory. In both cases, the patent work extended the creative scope of Szilard's science which was always already aimed at transforming the world. The patents gave him personal control of his ideas

and protected his creations from distorted applications. Understanding this need for creative control as a determining factor in Szilard's science of transmutation yields a fuller understanding of the extent of Szilard's patent work than simply reducing his patenting activity to his obvious financial needs. As a *Privatdozent*, Szilard needed the money that consultant work gave him, but the extent of this work and the continuity of this activity, which grew to include his theories on transmutation, reflected Szilard's need for control and his fear that his ideas, capable of transforming the world, would be used inappropriately, especially if he actually "discovered" the transmutative power of his thermodynamic world.

Indeed, Szilard's first attempts to find transmutation emerged in patents for a linear accelerator and a cyclotron. As he told it in his "Recollections," Szilard allowed his fertile imagination to drift back to physics for a few months in 1928 and 1929. He "began to think what might be the future development in physics." He decided that "Disintegration of the atom required higher energies than were available up to that time; there had been no artificial disintegration of the atom."[16] With this in mind, he designed and applied for patents for a linear accelerator (December 17, 1928) and a cyclotron (January 5, 1929).[17]

More than playful intellectual banter, as William Lanouette has described them, these patents logically

followed Szilard's electromagnetic pump and refrigeration designs and displayed Szilard's interest in the practical application of electromagnetic fields.[18] The linear accelerator showed that Szilard understood the use of potential differences to accelerate charged particles, and the cyclotron represented Szilard's conception of how the path of the accelerated particles could be bent by electromagnetic fields. In addition to showing his technical expertise in electromagnetic and atomic theory, the accelerator patents illustrated his desire to study the inner workings of the atom, extending the metaphorical visual perception of X-ray crystallography to the nucleus. Originally, Röntgen had used X-rays to see the inner workings of the body. X-ray crystallography extended that use to the atomic structure of matter. Szilard now wanted to see the nucleus by bombarding it with high energy particles. Out of this vision, Szilard hoped for more than extending the range of the scientific understanding of matter. He hoped that disintegration might lead to artificial radiation. As he said of his accelerator patents in a letter to Fermi some years later:

> In 1928 I formed the mistaken view that artificial disintegration would be developed in the course of a few years and would soon lead to practical application of very great importance. At that time I filed three patents which described the methods for the production of fast protons.[19]

At this point in Szilard's story, the political

circumstances of Weimar Germany joined Szilard's vision of a transmutative power. Noting a utilitarian aspect of German political culture, his own political "science" emerged, as evidenced by "*Der Bund*," making the power of his science even more important and the search for the power of the nucleus even more urgent:

> What I noticed was that the Germans always took a utilitarian point of view. They asked, "Well, suppose I would oppose this thinking, what good would I do? I wouldn't do very much good, I would just lose my influence. Then why should I oppose it? You see, the moral point of view was completely absent, or very weak, and every consideration was simply consideration of what would be the predictable consequence of my action.[20]

Following this analysis, Szilard stated bluntly in his "Recollections," "I reached the conclusion something would go wrong in Germany very early."[21] The remarks of Dr. Hjalmar Schacht, president of the German Reichsbank in February of 1929, reinforced this conclusion. According to Szilard, Dr. Schacht stated that "Germany could not pay any reparations unless she got back her former colonies." This statement shocked Szilard, leading him to believe that if Schacht could get away with saying that, then "things must be rather bad."[22] He therefore decided to move all of his money out of Germany and into Switzerland, although he stayed in Berlin with his suitcases packed. He wrote "*Der Bund*" and tried to convince others of its importance. He visited London and entered the United States on a immigrant visa around Christmas of 1931, returning to Berlin in May of

1932.

When he came back to Berlin in May, he decided to move to the Harnack House, the faculty club of the Kaiser Wilhelm Institute. By this time he had decided, at least tentatively, to do some kind of work in nuclear physics. In late 1932, he "discussed the possibility of doing experiments in nuclear physics with Miss Lisa Meitner in the Kaiser-Wilhelm-Institute für Chemie."[23] The political circumstances, however, overwhelmed his interest in nuclear physics, and Szilard decided "to delay a final decision" on whether or not to turn his attention full time to nuclear physics.[24] At the time of the *Reichstagsbrand*, February 27, 1933, Szilard talked to his friend Michael Polanyi and tried to convince him of the seriousness of the situation. He was not able to convince Polanyi to accept a position in England, but Szilard himself decided to leave Germany, and around the first of April he boarded a train to Vienna. According to Szilard, his train was empty, but the next day:

> The same train . . . was overcrowded, was stopped at the frontier, the people had to get out, and everybody was interrogated by the Nazis. This just goes to show that if you want to succeed in this world you don't have to be much cleverer than other people, you just have to be one day earlier.[25]

From Berlin Szilard went to Vienna and stayed there for about a month. During this time he met Dr. Jacob Marschak, an economist at Heidelberg. Marschak and Szilard discussed the problem of refugee scholars:

> I told him that I thought that since we were out here we might as well make up our minds [about] what needed to be done to take up this flood of scholars and scientists who would have to leave German universities soon.[26]

Through a series of personal contacts starting with Marschak, Szilard met Sir William Beveridge of the London School of Economics. Beveridge agreed that something needed to be done and suggested that Szilard come to England and occasionally prod him on the subject. These conversations were the beginning of the English Academic Assistance Council.

Around the first of May, Szilard moved to London, took up residence in the Imperial Hotel and contacted Beveridge concerning their conversations in Vienna. In a letter to Beveridge dated May 4, Szilard suggested creating an "International Board" which would be responsible for selecting scholars who needed assistance. Szilard addressed these same concerns in another letter (dated May 7) to Dr. G. Donnan, a professor at University College, London.[27] These letters indicated the beginning of a commitment that occupied Szilard for the next several months. He worked diligently for the Academic Assistance Council and had little time for anything else, pushing all scientific concerns to the back of his mind. A letter dated August 11 showed Szilard's preoccupation with political and personal concerns. He noted that, "I have been working all day at the Academic Assistance Council."[28] He was "rather tired" and

pessimistic and forlornly forecast that there would soon be "two heavily armed antagonistic groups in Europe, and the consequences will be that we shall get war automatically."[29] His personal situation was tenuous also. Although he was working for the Academic Assistance Council, he had no official university position; "Of course, it is impossible to apply for a fellowship for myself with those English committees on whose work I have a direct influence."[30] He did not know what he was going to do or where he was going. He wanted to stay in England but was considering going to the United States or even India. In an unusually personal remark, Szilard commented:

> I am spending much money at present for travelling about and earn of course nothing and cannot possibly go on this way for very long. At the moment, however, I can be so useful that I cannot afford to retire into private life.[31]

It was the first of September before Szilard was able to retire into private life. For him this meant a re-evaluation of his scientific interests. He contemplated going into biology and visited A. V. Hill, a professor of physiology at the University of London. Hill had made the switch from physics to biology himself and suggested that Szilard do the same.[32] Szilard seriously considered this. Biology was a field which "suited his temperament," according to his friend Eugene Wigner, but he did not make the switch.[33] Nuclear physics returned to the forefront of Szilard's mind, but now the full significance of his

scientific work had been transformed. He had experienced the horror of the Nazis and had helped to ensure the survival of many important scientists through the Academic Assistance Council. He knew the world was a dangerous place, and in such a world, science, and in particular, nuclear science had a very special role to play. The creative power of science could not be allowed to be deformed by the Nazis. The world had to be transformed and scientific knowledge controlled for the good. Szilard, the scientist, was now locked in a tragic struggle to "Save the World," guided by a vision of science that both frightened and emboldened him to pursue political and scientific transmutation.

It was at this point in his "Recollections" that Szilard recalled the fiction of H.G. Wells:

> Now I must tell you why I did not make this switch [to biology] at that time . . . In 1932, while I was still in Berlin, I read a book by H.G. Wells. It was called *The World Set Free* . . . . This book made a very great impression on me, but I didn't regard it as anything but fiction. It didn't start me thinking of whether or not such things could in fact happen."[34]

Wells's book, published in 1914, described "the discovery of artificial radioactivity" according to Szilard. The first chapter of Wells's book pictured a professor lecturing audiences on the incredible possibility of harnessing the powers that enabled radium and other naturally radioactive substances to disintegrate.[35] By the end of the book the world was "set free" from the social, political and

intellectual chains of the past by the destructive and liberating forces unleashed by the power of atomic energy. Wells work depicted the power of science and the scientist in his visionary character Marcus Karenin: "Science is no longer our servant. We know it for something greater than our little individual selves. It is the awakening mind of the race."[36] Kerenin's vision ultimately represented Wells's vision of how science would set the world free.

While labeling the latter parts of Wells's story unrealistic and utopian, Szilard noted that Wells's fictional account of the development of atomic power was "vivid and realistic." He also gave the impression that Wells's story shaped the context of his understanding of the liberating possibilities of atomic energy. He especially noticed the coincidence of Wells putting the discovery of artificial radioactivity in the same year as the actual discovery, 1933, and the realism of Wells's fictional scenario depicting:

> the liberation of atomic energy on a large scale for industrial purposes, the development of atomic bombs, and a world war which was apparently fought by an alliance of England, France, and perhaps America, against Germany and Austria, the powers located in the central part of Europe.[37]

By making these connections between his story of "discovery" and Wells's story of scientific transformation, Szilard described a deep connection between Wells's fictional nuclear transmutation, through which science transformed the world, and his own "discovery" of transmutation. Szilard's

"discovery" now reverberated the power of Wells's science, a science whose discoveries transformed the world and set it free.

In recalling conversations with Otto Mandl in the "Recollections," Szilard again linked the creative impulse of science displayed in Wells's science fiction with his discovery. Otto Mandl, an Austrian who had gone to England and become "a wealthy timber merchant," had also been interested in H.G. Wells for some time. According to Szilard, Mandl had discovered Wells before he was well-known on the continent of Europe and had succeeded in obtaining exclusive rights to publish Wells's works in German. Mandl and Szilard met in Berlin sometime in 1932 and discussed Wells's work and ways in which Man might be saved from "a series of ever-recurring wars that could destroy it." Mandl maintained that "Man has a heroic streak" and needed a task which would satisfy his appetite for heroism and "the need to fight and encounter danger."[38] He decided that Man must "launch an enterprise aimed at leaving the earth."[39] Szilard recalled that he was fascinated by this idea, even though he did not necessarily completely agree with Mandl. But he did conclude at the time of the conversation that if he ever decided that an enterprise to leave the earth was necessary, then he would study nuclear physics "because only through the liberation of atomic energy could we obtain the means which would enable man not only to leave the earth but to

leave the solar system."[40]

Szilard's answer to the heroic struggle portrayed by Mandl, reiterated in the "Recollections," inscribed into the story of his discovery the liberating power of nuclear science that both Mandl and Szilard saw in Wells's fictional world. Quite literally nuclear power could free Man from his earthly chains and transform the world. Of course, this was only a fiction for Szilard, but in recalling it he again displayed his vision of a scientist whose breakthroughs were "not logically derived from pre-existing knowledge" and who operated "on the level of the subconscious."[41] As such, it is a revealing story of the "subconscious" transmutational vision that became his creative obsession, so much so that he no longer had to consciously think of it:

> I was no longer thinking of this conversation, or about H.G. Wells's book either until I found myself in London about the time of the British Association [meeting] in September of 1933.[42]

Szilard's "subconscious" vision soon collided with the wisdom of a legendary figure in nuclear physics. The English physicist Lord Rutherford delivered a speech before the British Association for the Advancement of Science on September 11, 1933. A summary of that speech published in *Nature* contained the following sentence: "One timely word of warning was issued to those who look for sources of energy in atomic transmutations--such expectations are the merest of moonshine."[43] When Szilard read an account of this speech

in the newspapers, it created an idea in his mind that "never left" him, according to his "Recollections." In his famous epiphany at the stop light, Szilard theorized that a nuclear chain reaction might be sustained by the production of neutrons. Such a chain reaction, according to Szilard might make it possible to "set up a nuclear chain reaction, liberate energy on an industrial scale and construct atomic bombs."[44] He did not know what element might be able to do this or what experiments needed to be done, but from that moment on, he was convinced of its possibility: "The thought that this [liberation of atomic energy] might be in fact possible became a sort of obsession."[45] Szilard's personal transformation was now complete. In the story of his obsessive pursuit of the liberating power of atomic energy, he had now become the tragic scientist possessed by the idea of transmutational power.

According to his "Recollections," other scientific developments soon confirmed that his thinking was not the "merest of moonshine." On January 18, 1934, Irene Curie and Frederic Joliot discovered artificial radioactivity. According to Szilard, "I suddenly realized that the tools were at hand to explore the possibility of a nuclear chain reaction."[46] He tried to inform others of his vision of a nuclear chain reaction. He talked to G. P. Thomson, a physicist at the Imperial College of Science in London, and P. M. S. Blackett, a physicist at the University of London,

but he could not "invoke any enthusiasm."[47] He applied for a patent on his ideas on the "Transmutation of Chemical Elements" on March 12, 1934. In a letter to Sir Hugo Hirst, founder of the British General Electric Company, dated March 17, Szilard could hardly contain his enthusiasm for his vision of nuclear transmutation as outlined in this patent. He suggested that Sir Hugo read the first chapter of H. G. Wells's *The World Set Free* and noted:

> Of course, all this is moonshine, but I have reason to believe that so far as the industrial application of the present discoveries in physics are concerned, the forecast of writers may prove to be more accurate than the forecast of scientists. The physicists have conclusive arguments as to why we cannot create at present new sources of energy for industrial purposes; I am not sure they do not miss the point.[48]

By late April of 1934, Szilard had moved to the Strand Palace Hotel in London where he soaked in the bathtub located down the corridor from his room; "I would just soak there and think, and around twelve o'clock the maid would knock and say, 'Are you all right, sir?'"[49] But Szilard was not alright. He was in pursuit of a fantastic vision.

During the summer, his search became more practical. He approached the chairmen of the physics department at Bartholomew's Hospital in London about using their radium for some experiments in nuclear physics. The chairmen approved with the proviso that Szilard team up with a member of the staff at the hospital. He teamed up with T. A.

Chalmers, a physicist at St. Bartholomew's Hospital, and they began to explore the possibility that beryllium could sustain a nuclear chain reaction. By the fall of 1934, he had come to the conclusion that beryllium would not, and he broadened his perspective. He decided "that the reasonable thing to do would be to investigate systematically all the elements," but he could not generate much enthusiasm for what would have been a very time-consuming and expensive project, especially since most physicists did not think a nuclear chain reaction was possible.[50] They were not convinced, as Szilard was, of its importance. They did not see as he did.

Blackett suggested that Szilard go to Russia if he wanted to get support for such a large undertaking; "If a Russian physicist went to the government and says,[sic] 'We must make a chain reaction,' they would give him all the money and facilities he would need. But you won's get it in England"[51] Some physicists even resented Szilard's patent application. In a letter from Micheal Polanyi to Szilard, Polanyi noted: "Donnan told me that there is an opposition to you on account of taking patents. A physicist (not Rutherford) told him so."[52] Nevertheless, Szilard persevered. A memorandum from Szilard to Professor Lindemann of the Clarendon Laboratory at Oxford clearly showed that Szilard had not given up on his idea of a nuclear chain reaction. He was still obsessed with the prospect and

reiterated his commitment in a June 3, 1935 memo:

> It seems to me that the question of whether or not the liberation of nuclear energy and the production of radioactive material on a large scale can be achieved in the immediate future, hinges on the question of whether or not "double neutrons" can be produced. If "double neutrons" can be produced, then it is certainly less bold to expect this achievement in the immediate future than to believe the opposite.[53]

Convinced of his vision, he began to worry that he could not control his discovery. In 1936, Szilard's fears of the military application of his nuclear transmutation concept led him to assign one of his patent applications to the British Admiralty. He felt that "it contains information which could be used in the construction of explosive bodies based on processes described in the Specification. Such explosive bodies would be very many thousand times more powerful than ordinary bombs."[54] He also began to try to convince Enrico Fermi and Emilio Segrè, two prominent Italian physicists studying the effects of neutron bombardment, to patent their inventions related to nuclear physics. Szilard explained that he had not filed patents for personal gain. He only wanted to use the money obtained from these patents to create an independent nuclear physics research institute. Szilard justified himself in the following way:

> I feel I must not consider these patents as my private property and that if they are of importance, they should be controlled with a view of public policy. I see no objection to a commercial exploitation of some such patents, but I believe that the income (if there is any

> substantial income) should not be used for private purposes, but rather for financing further research or, if the income is very large, for other constructive purposes.[55]

Whether it was the destructive power of explosive bodies or the constructive purposes of a nuclear research facility, Szilard recognized the importance of controlling his vision. Locked in a tragic struggle prescribed by his tragic science, he saw himself, in his "Recollections" of it, transformed into a obsessive visionary trying to explain his vision to a world that he knew would be transformed by it in ways that he might not be able to control. Szilard's "discovery" cannot be separated from this context. He inscribed his vision of transmutation and his tragic struggle to control his "discovery" into his scientific papers of the early 1930's.

Szilard's first attempt to articulate his vision of nuclear transmutation echoed his thoughts on atomic disintegration of 1928 and 1929. Returning to his ideas on particle accelerators, he filed a patent application on "Asynchronous and Synchronous Transformers for Particles" on February 21, 1934:

> The invention concerns methods and apparatus for the production of fast charged particles, e.g. electrons or protons. All these methods, described below, are based on multiple accelerations, i.e. the velocity of the particle exceeding the maximum voltage which arises between any two parts of the apparatus.[56]

In this patent application Szilard continued his thoughts on the disintegration of atom using high energy electron and

proton bombardment and designed smaller accelerators capable of higher energies. For example, instead of using a single iron core to create a magnetic flux that will accelerate electrons, Szilard suggested that "one can obtain a less heavy apparatus by utilizing several half cycles of the changing flux." The electron would then "encircle different iron cores during subsequent half cycles of the changing flux . . . . The number of magnets to be used is only limited by the length of the transformer frame which can be made so as to suit the purpose."[57] Szilard called this setup a "single phase multiple action transformer."[58] In this system, the electron was accelerated by sending it into asynchronous magnetic fields, magnetic fields whose voltages vary with time and whose strengths gradually increase, increasing the speed of the captured electron in the process. His synchronous accelerator design, also a part of this patent application, envisioned using an "extremely high frequency electric oscillator" instead of an iron core to produce a synchronous magnetic field in which the voltage does not vary with time. The particle would then be accelerated by sending the electron across a potential gap and varying the oscillating frequency of the system.[59]

Higher energies or not, the accelerators did not address the central idea of Szilard's nuclear vision, neutron bombardment and nuclear transmutation. Now Szilard turned his attention to articulating this aspect of his

nuclear vision in 1934. Szilard's thoughts on this obsession came in two forms. He filed a number of patents on the subject, and he teamed up with T. A. Chalmers during the summer of 1934 to experiment with beryllium.

Szilard's March 12 patent application, "Transmutation of Chemical Elements" reiterated Szilard's vision of the power of transmutation:

> The invention concerns methods and apparatus for the production of nuclear transmutation leading to the generation of radioactive bodies, to the storage of energy by means of the generation of radioactive bodies and the utilisation of the energy which has thus been stored for the production of heat and power, further to the liberation of nuclear energy and the utilisation of the liberated energy.[60]

Building on Joliet-Curie's work, Szilard began by stating "It is not new to produce elements capable of spontaneous transmutation by bombarding certain elements with fast charged nuclei" and describing the limits of using this method on the heavier elements.[61] Instead he suggested using a neutron source to transmute the element into a radioactive element and noted:

> The transmutation of elements into radioactive bodies under the influence of neutrons can be demonstrated even before one knows which elements will transmute into radioactive bodies, if one prepares a mixture of all suitable elements . . . and exposes this mixture to a neutron radiation.[62]

He then described his method for producing neutrons and using those neutrons to create transmuted elements; "If a nuclear reaction of diplogen [heavy hydrogen or deuterium] with itself is enforced through heating up diplogen with an

electric discharge, a neutron radiation is emitted which can be used for the generation of radioactive bodies."[63] This entailed discharging an electric condenser or multiple condensers into a "transmutation space" filled with diplogen.[64] The resulting high, concentrated energy burst would lead diplogen to react with itself and give off neutrons which could be used to irradiate heavy elements.

In academic nuclear physics, this "discovery" constituted Szilard's major scientific achievement in nuclear physics. In the patent, Szilard used the example of how this might be done with beryllium as his transmutative element and described how transmuted elements, transformed into their radiative isotopes, might be separated after irradiation:

> Those atoms of our element which transmute into a radioactive atom are thrown out of the compound and will subsequently be called 'free.' If we choose a compound which in the circumstances does not interchange the atoms of our element bound within the compound with the 'free' atoms which are the isotopes we can chemically separate the 'free' atoms from the compound and thereby separate the radioactive isotope from the irradiated element.[65]

Given in brief in the patent, this invention described most of the work he did with T. A. Chalmers that was published in the journal *Nature* in the Fall of 1934.[66] The isotope separation process would later become known as the Szilard-Chalmers effect, and it was the one development in nuclear physics which most physicists associated with Szilard.[67]

Only a minor part of his original patent application,

this work did not represent the "discovery" that Szilard envisioned. The transmutation that Szilard believed in involved the "discovery" of a nuclear chain reaction, an important extension of the idea of transmutation by neutron irradiation. What Szilard visualized was the production of double neutrons when a heavy element was bombarded by neutrons:

> The interaction of a neutron with matter can lead to the liberation of further neutrons--these newly liberated neutrons liberated again in their turn further neutrons so that we can have a chain reaction in which a large number of neutrons are liberated.[68]

If that could happen, then all sorts of things were possible. A "chain reaction apparatus" could be constructed. Using a "high voltage canal ray tube," fast deutons [deuterium ions] could be produced. These deutons would strike a deuterium target thereby generating neutrons. Referring to a diagram that accompanied the text Szilard explained that these neutrons would act "on matter 3 which fills the transmutational space." This unspecified matter, which Szilard thought at the time to be beryllium, would sustain a nuclear chain reaction. That is, it would follow the neutron liberation process outlined in the quotation above. The matter in the transmutational space would be surrounded by a series of pipes which contained water or mercury and would act as a cooling system to the "transmutational area" and drive heated liquid to a boiler that would supply steam to a power plant.[69]

This transmutational power plant represented an essential part of Szilard's "discovery." As his patent application of March 1933 displayed, Szilard "invented" the idea of the transmutational power of nuclear transmutation through neutron bombardment, what he called a nuclear chain reaction. The search for the unspecified matter to fill the transmutational space possessed him from then on. Everything else flowed from his vision of the power of transmutation which already contained within it creative and destructive power.

Szilard made the destructive nature of his "discovery" clear in his first patent when he discussed the importance of the shape and size of the "transmutational space." In this discussion, he outlined the idea of "critical value" by which he meant the relationship between the density of the neutrons being emitted and the inner radius of the closed spherical layer of transmutational material. He recognized that if one went beyond a certain thickness in the transmutational material, the nuclear chain reaction would explode: "If the thickness is larger than the critical value 1, we can produce an explosion."[70]

The key to unlocking this destructive power, as Szilard understood from the beginning, was finding the elusive elixir, the "metastable element." In his original patent application, he described metastable elements, in particular metastable elements that might sustain a nuclear chain

reaction. He noted in his patent:

> Pure neutron chains . . . are only possible in the presence of a metastable element. A metastable element is an element the mass of which (packing fraction) is sufficiently high to allow its disintegration into its parts under the liberation of energy. Elements like uranium and thorium are examples of such metastable elements; these two elements reveal their metastable nature by emitting alpha particles. Other elements may be metastable without revealing their nature in this way.[71]

Szilard then indicated that he thought beryllium might be the metastable element that released two neutron when it absorbed one, thereby, liberating energy.

As it turned out, Szilard was mistaken; despite his efforts to expand his search to all the elements, as was mentioned above, he did not discover what would be called later nuclear fission. But his "discovery" was just as significant for our understanding of the mythos of nuclear physics in the twentieth century. Szilard discovered the idea of a nuclear chain reaction and that idea resulted from none other than Szilard's tragic obsession with the transmutational power of the nuclear chain reaction. Szilard's tragic discovery comprehended all of nature and all of the world in terms of this transmutational power which could lead to almost unlimited power and horrible destruction. His tragic vision defined itself in terms of its transmutational value for society, and Szilard's "discovery" transmuted nuclear science into an arcanum.

In March of 1939, after the discovery of nuclear

fission, and after the properties of "metastable elements," were more clearly understood, Szilard again reiterated his transmutational understanding of atomic energy. He filed a patent application for an "Apparatus for Nuclear Transmutation" in which he repeated his description of a nuclear chain reaction capable of generating power and producing "explosive bodies in which an explosion is brought about at will by a sudden change in the distribution of matter."[72] But this time Szilard knew the "metastable element" capable of absorbing one neutron while emitting two, and it was simply a matter of putting uranium into the "transmutational space" that was always present in Szilard's tragic vision:

> It is easily demonstrated that uranium emits a large number of neutrons while it is exposed to the slow neutron stream and the number of neutrons which are thus instantaneously (within a fraction of a second) emitted from uranium per number of incident neutrons which are captured in the reaction with uranium is larger than one.[73]

The power always already envisioned by Szilard's tragic science now had became a mythological reality, committed to the truth of transmutation, confident in the ability of atomic power and atomic scientists to save the world, fearful of the destructive power of the atom, and tragically persevering in arcane silence a quest for a power he knew in time he would discover. Within this mythological context, "discovered" by Szilard and displayed in his science, the explosions at Hiroshima and Nagasaki assume their full

tragic meaning, a meaning always already described by scientists who defined themselves in terms of a tragic search for transmutation and portrayed themselves as creative controllers of a transmutative power.

Notes

1. Tristram Coffin quoting Szilard, "Leo Szilard: The Conscience of a Scientist," *Holiday*, 35(Feb. 1964): 68.

2. Leo Szilard, "Recollections" in *Leo Szilard: His Version of the Facts*, Spencer R. Weart and Gertrude Weiss Szilard, eds. (Cambridge, Mass.: The M.I.T. Press, 1978): 17. Hereafter cited as "Recollections." This epiphany occurred as Szilard was thinking about a speech made by Lord Rutherford at the British Association for the Advancement of Science in which he said: "One timely word of warning was issued to those who look for sources of energy in atomic transmutations- such expectations are the merest of moonshine." Szilard, "Recollections," 17- editors footnote 23.

3. Eugene P. Wigner, "Leo Szilard" in the National Academy of Sciences, *Biographical Memoirs*, 40(New York: Columbia Univ. Press, 1969): 338.

4. Ibid.

5. "A Simple Test for the Detection of a Selective Effect by the Dispersion of X-Rays" (June 23, 1925) and "The Polarization of X-Rays by Reflection in Crystals" (November,27, 1925), reproductions of the original German patents in Leo Szilard, *The Collected Works of Leo Szilard: Scientific Papers*, ed. by Bernard T. Feld and Gertrude Weiss Szilard (Cambridge, Mass.: M.I.T. Press, 1972): 130-138. Hereafter cited as *Scientific Papers*.

6. Hermann Mark, "Recollections of Dahlem and Ludvigshafen," in *Fifty Years of X-Ray Diffraction*, ed. by P. P. Ewald (Utrecht, The Netherlands: N.V.A. Oosthoek's Uitgeresmaat-schappij, 1962): 605, 606.

7. Ibid.

8. A. L. Patterson, "Experiences in Crystallography- 1924 to Date," in *Fifty Years of X-Ray Diffraction*, 616. My emphasis.

9. William Lanouette with Bela Szilard, *Genius in the Shadows: A Biography of Leo Szilard, the Man Behind the Bomb*. (New York: Charles Scribner's Sons, 1992): 90-93.

10. Szilard, *Scientific Papers*, 697-699, 706, 708.

11. Ibid., 697.

12. Szilard, "Recollections," 12. Einstein and Szilard shared eight German patents between 1927 and 1930 on various aspects of this refrigerator design. The first of these patents was filed in Germany on November 13, 1927 and was titled simply "Refrigerator." They also filed this patent in England as they did many of their refrigerator and pump designs. Of the seven German patents shared between Szilard and Einstein, three of them dealt with the design of the liquid metal pump, patent numbers 554959(December 28, 1927), 562040(June 1, 1928), and 555413(December 4, 1928). Supplemental patent number 562898(April 15, 1930) also dealt with the pump design. These patents, which were of special interest to AEG, enabled Szilard to act as a consultant to AEG for about three years, presumably from 1927 to 1930 or early 1931.

Szilard also filed a number of patents on his own which were related to this work. On October 16, 1928 he filed an English patent for a condenser. In Germany, he patented various pump designs in April and June of 1929. Finally, in 1931 the last of the patents related to this work was filed in early January. For a list of Szilard's patents related to the refrigeration system, see Szilard, *Scientific Papers*, 697-706.

In addition to his refrigeration patents, Szilard patented "A Method for the Electrochemical Drawing of Sound Currents, and a design for an electron microscope. See Szilard, *Scientific Papers*, 706-707.

13. Szilard stated in his "Recollections" that German General Electric Company (AEG) showed great interest in the design, hiring Szilard as a consultant and funding the building of a prototype. Szilard, "Recollections," 12.

14. Ibid.

15. Ibid. This liquid metal pump design was not forgotten however. It was resurrected with the development of coolant systems in atomic reactors after World War II. For a recounting of all the activities related to the refrigerator, see William Lanouette with Bela Szilard, *Genius in the Shadows*, 83-84.

16. Szilard, "Recollections," 11.

17. Leo Szilard, "Beschleunigung von Korpuskeln," and "Korpuskularstrahlröhre," in *Scientific Papers*, 544-553, 554-563. Neither of these patent applications were ever issued into a patent and remained virtually unknown. Here is a sample from Szilard's linear accelerator patent: "Die Wirkungsweise der Anordnung is wie folgt: Betrachten wir ein positives Jon, das im Kanalstrahl fliegt und in einem solchen Augenblick durch das Gitter 1 hindurchfliegt, in welchem das Potential das Gitter 1 gegen das Gitter 2 gerade Null und im Wachsen begriffen ist. Das Jon wird dann im Raume zwischen den Gitter 1 und 2 beschleunigt und passiert das Gitter 2 (in dem Idealfall, den wir jetzt betrachten) gerade im dem Augenblick als der Potentialunterschied zwischen 1 und 2 wieder Null geworden ist. Dann ist auch der Potentialunterschied zwischen 2 und 3 Null und das Potential von 2 gegen 3 im Wachsen begriffen, sodass das Jon zwischen 2 und 3 wieder beschleunigt wird. u.s.w." [The mode of operation of the arrangement is as follows: Consider a positive ion that flies into the canal ray and in one such moment flies through Grid 1, in which the potential of grid 1 toward grid 2 is approaching precisely zero. The ion in the space between grid 1 and grid 2 is then accelerated and is passed to grid 2 (in the ideal situation that we are now looking at) just at the moment when the potential difference between 1 and 2 has become zero again. Then the potential difference between 2 and 3 is also zero and the potential from 2 towards 3 is approached, so that the ion is again accelerated between 2 and 3.] Leo Szilard patent, "Beschleuningung von Korpuskeln" in *Scientific Papers*, 547-548.

According to Julius Tabin, one of the editors of Szilard's *Scientific Papers*: "His [Szilard's] cyclotron application (which appears to predate the work of Lawrence) contains a description of the basic principles of the cyclotron including a discussion of the stability of the orbit brought about by having the magnetic field decrease in strength with increasing radius." He also notes that Szilard's linear accelerator patent application seems to predate Rolf Wideröe's paper on the subject. (Julius Tabin, "Introduction" to Patents in *Scientific Papers*, 528, 543.) The fact that Szilard's patent applications seem to predate Wideröe's and E.O. Lawrence's work is not important here since the focus of this discussion is the significance of Szilard's interest in "disintegration" and its relationship to the story of Szilard's discovery of transmutation. These priority problems, therefore, will not be discussed.

18. Lanouette, *Genius in the Shadows*, 101.

19. Szilard to Fermi, March 13, 1936, *Scientific Papers*, 729.

20. Szilard, "Recollections," 13.

21. Ibid.

22. Ibid.

23. Ibid.

24. Ibid.

25. Ibid., 13-14.

26. Ibid.

27. Szilard to Frederick G. Donnan, May 7, 1933, Document 3, *Leo Szilard: His Version of the Facts*, Spencer R. Weart and Gertrude Weiss Szilard, eds. (Cambridge, Mass.: The M.I.T. Press, 1978): 30, 32.

28. Szilard to [addresse unknown], August 11, 1934, Document 4, *His Version of the Facts*, 34.

29. Ibid., 35.

30. Ibid., 36.

31. Ibid., 36.

32. According to Szilard's "Recollections," Hill made the following proposal: "Why don't we do it this way. I'll get you a position as a demonstrator in physiology; and then twenty-four hours before you demonstrate you read up these things; and then you should have no difficulty in demonstrating them the next day. In this way, by teaching physiology, you would learn physiology; and it's a good place to begin." Szilard, "Recollections," 16.

33. Wigner, "Leo Szilard," 341.

34. Szilard, "Recollections," 16.

35. "Why does only a minute fraction of the radium disintegrate in any particular second? Why does it dole itself out so slowly and so exactly? Why does not all the uranium change to radium and all the radium change to the next lowest thing at once? Why this decay by dribbles; why not a decay <u>en masse</u>? . . . Suppose presently we find it is possible to quicken that decay?" . . . "Given that Knowledge," he said, "mark what we would be able to do!" H. G. Wells, *The World Set Free*: *A Story of Mankind* (New York: E. P. Dutton and Co., 1914), 23-24.

36. Wells, *The World Set Free*, 227.

37. Szilard, "Recollections," 16.

38. Ibid., 16-17.

39. Ibid.

40. Ibid.

41. Tristram Coffin quoting Szilard, "Leo Szilard: The Conscience of a Scientist," 68.

42. Ibid., 17.

43. Szilard, "Recollections," 17- editors footnote 23.

44. Ibid.

45. Ibid.

46. Ibid.

47. Ibid.

48. Szilard to Sir Hugo Hirst, March 17, 1934, Document 6, Szilard, *His Version of the Facts*, 38.

49. Szilard, "Recollections," 19-20.

50. There were ninety-two elements at the time.

51. Szilard, "Recollections," 18.

52. Michael Polanyi to Szilard, November 11, 1934, Document 8, Szilard, *His Version of the Facts*, 40.

53. Szilard to Lindemann, June 3, 1935, Document 9, Szilard, *His Version of the Facts*, 41.

54. Szilard to Dr. C. S. Wright, British Admiralty, Feb. 26, 1936, *Scientific Papers*, 733-734.

55. Szilard to Fermi, March 13, 1936 in *Scientific Papers*, 729.

56. Photocopy in *Scientific Papers*, 564-604. The quotation is on 568.

57. Ibid., 577-579. He also suggested creating an iron core by winding thin (1/10th mm) iron sheets instead of the usual a solid iron core. The result would be a more powerful and

lighter iron core. See page 581, 602.

58. Ibid., 579.

59. Ibid., 582-586. A patent was never issued on these designs that, according to Julius Tabin, contained certain aspects which ten years later were "utilized in completely revolutionizing the design of the cyclotron." Tabin, "Introduction" to patents, in *Scientific Papers*, 528.

60. Leo Szilard, "Transmutation of Chemical Elements" in *Scientific Papers*, 607.

61. Ibid.

62. Ibid., 608.

63. Ibid., 609.

64. Ibid.

65. Ibid., 610-611.

66. Leo Szilard, "Chemical Separation of the Radioactive Element from its Bombarded Isotope in the Fermi Effect," *Nature* Vol. 134 (September 22, 1934): 462; reprinted in *Scientific Papers*, 143-144.

67. In 1979, at a symposium on nuclear physics in the 1930's, the distinguished physicists Otto Frisch, discoverer of fission, and Maurice Goldhaber, a friend and colleague of Szilard's, recalled the importance of this contribution. Goldhaber called it the "ingenious Szilard-Chalmers method for separation of I^{128}." Roger H. Stuewer, ed. *Nuclear Physics in Retrospect: Proceedings of a Symposium on the 1930s* (Minneapolis, Minnesota: University of Minnesota Press, 1979): 94.

68. Szilard, "Transmutation of Chemical Elements" in *Scientific Papers*, 612.

69. Ibid.

70. Ibid., 614.

71. Ibid., 615.

72. Szilard, "Apparatus for Nuclear Transmutation" in *Scientific Papers*, 655-690. Quotation is on page 656.

73. Ibid., 664.

CONCLUDING REMARKS

As Szilard told us in his "Recollections," his science began with a tragic understanding of itself, persevering towards truth in the hope that it could save the world from the predetermined heat death so vividly and meaningfully described by Imre Madach's *The Tragedy of Man*. This heroic struggle gave meaning to Szilard's science, empowering his elitist vision of a society of scientists that saved the world, either from the Nazis (*Der Bund*) or from nuclear destruction (The Council for a Livable World.) Even in the imaginary worlds of his science fiction, Szilard returned to a tragic mythology of science. The fictional voice of Szilard matter-of-factly described the scientist as the tragic hero, creator and destroyer of worlds, cognizant and unrepentant of the power of his knowledge. This power came from his understanding and mastery of the thermodynamic world, tragically determined by the second law of thermodynamics. In this predetermined world everything became comprehensible to Szilard, including the purpose of science itself, to find the transformative power of his thermodynamic world though which he could transmute himself and the world. In his nuclear science Szilard displayed this tragic struggle to discover a transmutational power.

Szilard's obsession with the "discovery" of transmutation represented nothing less than this egoistic, neo-romantic fascination with power, and his nuclear science described a mythology of nuclear power as the modern arcanum. For this Szilard will always be remembered, because his life and science echoed the romantic immortality so aptly expressed by his dissertation director, Max von Laue: "He who is burning for a great cause will never quite perish."[1]

Notes

1. Max von Laue, "My Development as a Physicist," in *Fifty Years of X-Ray Diffraction*, 280.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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April 1994

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